BMC
International Health and Human Rights

Volume 9
Supplement 1
October 2009

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BMC

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The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants

Edited by Sharmila L Mhatre and Anne-Marie Schryer-Roy

The research presented in this journal supplement was carried out as part of the Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants (2003-2009), with funding from the Canadian International Development Agency (CIDA). These grants were provided through a competitive peer-review process to increase access to and enhance immunization services in CIDA's priority countries. The grants were overseen by the Global Health Research Initiative, which currently involves five major research/health agencies in Canada: International Development Research Centre (IDRC), CIDA, the Canadian Institutes of Health Research, Health Canada, and the Public Health Agency of Canada.

IDRC's Governance, Equity and Health program initiative provided the technical oversight for the CIII2 Operational Research Grants and for the creation of this journal supplement.

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International Health and Human Rights

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In an effort to increase the local relevance of the articles, all authors were given the opportunity to translate their abstract into one of the country of study's local languages for it to be included in this journal supplement. Translated abstracts are available for 8 of the 13 research articles and are presented at this back of this supplement.

BMC

International Health and Human Rights

Volume 9
Supplement 1
October 2009

BMC International Health and Human Rights is published by:

BioMed Central Ltd
Floor 6
236 Gray's Inn Road
London WC1X 8HL, UK
T +44 (0)20 3192 2000
F +44 (0)20 3192 2010
E info@biomedcentral.com

BMC International Health and Human Rights is an open access journal publishing original peer-reviewed research articles in relation to health and disease in developing and transitional countries, as well as all issues relating to the impact of health policies, programs and practices on human rights.

The journal can be found at http://www.biomedcentral.com/bmcinthealthhumrights/ (ISSN 1472-698X). Access to *BMC International Health and Human Rights* is free and available to all.

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Introduction

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The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. Results from the Canadian International Immunization Initiative Phase 2 – Operational Research Grants

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from The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants

Published: 14 October 2009

BMC International Health and Human Rights 2009, **9**(Suppl 1):S1 doi:10.1186/1472-698X-9-S1-S1

This article is available from: http://www.biomedcentral.com/1472-698X/9/S1/S1

Abstract

Immunization can and does save lives. However, the presence of vaccines does not easily translate into every child being vaccinated, and this is what the studies in this journal supplement reveal. From South Asia to West Africa, the evidence presented here reveals what we are calling the *fallacy of coverage*, going beyond uncovering the real vaccination rates to providing evidence on the reasons for the lack of effective coverage.

The evidence for the *fallacy of coverage* is part of an operational research program entitled the Canadian International Immunization Initiative Phase 2 (CIII2). Through a competitive peer review process, six research grants were awarded to increase access to and enhance immunization services. This journal supplement provides a forum for the presentation of the results of five of the six studies.

The story of the *fallacy of coverage* is made up of five theme areas of evidence – timeliness of immunization, social and gender inequities, vaccine efficacy, understanding demand side issues to tailor interventions, and national data sets masking actual district level coverage rates – that reveal the discrepancies in immunization coverage rates and the reasons behind these discrepancies. As part of the story, and to turn around the *fallacy of coverage*, the studies also provide proof of effective and locally relevant solutions.

Policies and funding, while keeping an eye on future diseases, clearly need to maintain and increase support to address *existing* vaccine-preventable diseases to increase coverage such that by 2015 we can achieve 90% national vaccination coverage and reach the MDG of reducing mortality rates among children under five by two-thirds. The results from the operational research grants of the CIII2 offer some answers on how to reach this goal by demonstrating how locally generated evidence can inform immunization strategies to ensure that children who need to get vaccinated will get vaccinated, and vaccinated on time.

Introduction

Immunization can and does save lives. With existing vaccines, it is estimated that between two and three million deaths from diphtheria, tetanus, pertussis and measles are prevented annually [1]. There is a strong global recognition that increasing immunization coverage is an essential step towards reducing child mortality, the fourth Millennium Development Goal (MDG). Currently as a response, the chief goal set by UNICEF and WHO is to, by 2015 or earlier, reduce illness and death due to vaccine-preventable diseases by at least two thirds compared to 2000 levels.

Examination of the top three vaccine-preventable diseases in all regions of the world reveals the importance of focusing efforts on increasing coverage of existing vaccines (See Table 1). However, the presence of vaccines does not easily translate into every child being vaccinated, and this is what the studies in this journal supplement reveal. While progress is being made with global agencies reporting coverage rates of 81% for infants receiving three doses of diphtheria, pertussis and tetanus (DPT3) [2] and measles vaccination reaching 80% [3], the articles in this journal supplement reveal great disparities among and within countries. As such, from South Asia to West Africa the evidence presented here reveals what we are calling the *fallacy of coverage*. The studies in this supplement go beyond uncovering the real vaccination rates to providing evidence on the reasons for the lack of effective coverage. Some go as far as introducing locally-relevant interventions that actually improve the coverage rates of measles and DPT3 [4,5].

The evidence for the *fallacy of coverage* is part of an operational research program entitled the Canadian International Immunization Initiative Phase 2 (CIII2), initiated in September 2003. This initiative is a project of the Global Health Research Initiative (GHRI), which involves the collaboration of five major research/health agencies in Canada: International Development Research Centre (IDRC), Canadian International Development Agency (CIDA), Canadian Institutes of Health Research (CIHR), Health Canada (HC) and the Public Health Agency of Canada (PHAC). It is an important precedent of funding organizations coming together, pooling resources and strengths, to invest in filling the gaps in immunization research.

Through a competitive peer review process, six research grants were awarded to increase access to and enhance immunization services in CIDA's priority countries. This journal supplement in BioMed Central's open access journal *BMC International Health and Human Rights* provides a forum for the presentation of the results of five of the six studies.

Table 1 - Top vaccine-preventable diseases by region.

Region	Diseases
South Asia	Measles, Tetanus, Pertussis
South-East Asia	Pertussis, Measles, Hep B
Latin America & Caribbean	Pertussis, Tetanus, Hep B
Sub-Saharan Africa	Measles, Pertussis, Tetanus

Source: http://www.worldbank.org/features/2006/tabledcpp.htm.

The first paper that follows provides a global overview of the progress to date in immunization and some of the challenges from the CIII2 partners. It discusses the various approaches used by WHO and UNICEF to improve immunization coverage and at the same time sets the stage for the research results of the CIII2 operational research grants by impressing on the need for evidence to realise the full "potential of immunization...in achieving the health-related MDGs"[6].

The subsequent 13 peer-reviewed papers unravel the *fallacy of coverage* and present the evidence for what is needed to get closer to achieving the fourth MDG. All the studies underline the importance of understanding the context in which the extent of immunization coverage is realised. Only through such operational and local research can we get the needed evidence to improve coverage – from South Asia to West Africa.

Theme areas of evidence

The story of the *fallacy of coverage* is made up of five theme areas of evidence that reveals the discrepancies in immunization coverage rates and the reasons behind these discrepancies. It also includes evidence for turning around this *fallacy of coverage*. The first theme is the challenge of ***timeliness or age-appropriate immunization***. This is evident in the studies presented in this supplement from India [7], Pakistan [4,8], and Burkina Faso [9,10]. By assessing coverage through the analytical lens of age-appropriateness of coverage, these studies bring into question the progress of immunization coverage. In fact, as seen by the evidence, while overall coverage can be deceptively good, the story changes when one takes into account whether or not vaccines are administered on time. In India for example, while immunization coverage has overall increased, the work by Corsi *et al.* [7] shows that, nationally, complete age-appropriate coverage is still under 50%. Not only do age-appropriate immunization rates provide a truer picture of actual coverage, but such an approach is also useful for health workers and service providers – as noted in the work by Dugas *et al.* [9] and Bicaba *et al.* [10] – as it allows them to improve and tailor their immunization strategies to increase coverage. The implications for not providing immunization on time are reduced benefit of the vaccine and increased mortality.

The critical importance of the timely immunization theme was recently detailed in a review of data from 45 low-income and middle-income countries published in the *Lancet* [11].

The next key theme area of evidence to better understand the *fallacy of coverage* is the issue of ***social and gender equity***. Work by Corsi *et al.* [7] demonstrates that the progress of immunization coverage in India is hindered by the persistence of ***gender inequities*** across all socio-economic levels, resulting in girls having significantly lower coverage rates for bacille Calmette-Guérin (BCG), oral polio vaccine (OPV), DPT and measles vaccination. Interestingly, gender inequities affect who gets immunized or not, but does not affect the decision to immunize on time. Gender also needs to be considered in targeting interventions, as demonstrated through an in-depth ethnographic study by Dugas *et al.* [9] in Burkina Faso. The researchers found that in some communities despite the father's decision to vaccinate the children, mothers do not always bring them to be immunized. This gap between decision-making and actual vaccination practice requires interventions that target both parents.

The linkage between poor coverage and increasing inequities is demonstrated in the studies in Pakistan and Burkina Faso. Mitchell *et al.* [8] provide evidence on how ***poor access and mother's education*** (in urban areas only) were the key equity factors obstructing measles vaccination uptake in the Lasbela district of Pakistan. In the Nouna district of Burkina Faso, Sanou *et al.* [12] provide evidence for how the ***education of both parents*** along with the economic conditions of households affected immunization coverage. The authors did note, however, that the influence of economic conditions is complex as immunization services are free of charge, thus pointing to the importance of communication about the free services to avoid potential abuses by providers.

In addition to inappropriate coverage and increasing inequities linked to coverage, the Pakistan study uncovered the next key theme area, which is that of ***vaccine efficacy***. Through the development of a communication tool (a "balance sheet" summarizing published evidence on benefits and possible adverse effects of vaccination) to enable communities to balance costs and benefits of measles vaccination, Ledogar *et al.* [13] uncovered a much *lower vaccine efficacy rate* in Lasbela, Pakistan, than expected. As such, the rate they found was 41.5% compared to the rate generally found in developed countries of 95% (range of 90-98%) [14]. Reasons for this discrepancy are discussed in the paper. While this "balance sheet" was not used in the randomised controlled trial of a community intervention in Lasbela, Pakistan, such a tool could serve as a web-based reference for project managers and health officials, helping them identify areas of improvement in immunization services.

Many of the articles in this supplement offer a strong demand side perspective, i.e. from existing and potential beneficiaries. This ***demand side evidence*** is the next key theme area which looks behind the discrepancies in vaccination rates to help tailor potential solutions. In the Pakistan series of articles, Shea *et al.* [15] conducted a systematic review of the literature on the impact of demand side interventions, demonstrating existing gaps and highlighting the need for such operational research. By focusing on the demand side, Dugas *et al.* [9] provide an increased understanding of why there is a lower than expected coverage rate in a health district in Burkina Faso. Their study points to the need to tailor interventions such that they take into account ***parents' perception of childhood illness*** and to the need to examine ***local vaccination procedures or requirements***. In this particular case, their research found that vaccination procedures served to deter rather than ensure access. In practice, immunization access was conditional on women going for antenatal care and acquiring and preserving a vaccination booklet for their child. In the same vein, Bicaba *et al.* [10] argue for the importance of understanding the ***reasons why some children are still not completely vaccinated***.

As part of a demand side analysis, understanding the local context is one of the keys to unravel the *fallacy of coverage*. Fourn *et al.* [16] in Benin ask the question: what are the factors that lead to reticence to vaccination among religious populations? Through the use of qualitative methods, their results suggest that ***interpretation of religious principles*** by church-going populations is primary in explaining reticence and that the solutions lie in ***creating an open dialogue among all actors***: reticent parents, their religious leaders and health authorities. Such an intervention is also alluded to by the work in Burkina Faso by Sanou *et al.* [12] and national EPI teams have used the results of the study.

The local level analyses also provide valuable information on existing immunization programs/campaigns. For example, Mitchell *et al.* [8] note that while other areas in Pakistan have demonstrated the positive impact of mobile vaccination teams, this was not the case in Lasbela district. Similarly, as seen in Burkina Faso, Haddad *et al.* [17] note that Immunization Days did not have any impact on the performance of routine vaccination services. While both authors discuss this finding in their papers, it is worthy to note that these results from South Asia to West Africa further underscore that ***blueprint national programs/campaigns often do not resonate with communities*** as their assumptions are disconnected from

local realities. Local data can be used to tailor such programs/campaigns to increase their effectiveness.

The studies in this supplement provided evidence from a local/district level and also compared their results to national data sets, thus presenting the last key theme area with regards to the *fallacy of coverage*. In the article by Cockroft *et al.* [18] the authors unravel a complex context where actual coverage rates are ***masked by national rates***, and where there is ***heterogeneity in vaccination coverage*** between and within districts, and particularly between urban and rural areas in Pakistan. Despite this heterogeneity, as Cockroft *et al.* [18] point out, there is some ***commonality in the variables*** associated with vaccination uptake such as the quality of services, mother's education and knowledge of benefits. Local evidence on these issues can then be used to turn around the *fallacy of coverage*, thereby increasing immunization uptake.

Evidence of locally relevant solutions

Beyond the five key theme areas of evidence that emerge from this supplement, the various studies also highlight effective and locally relevant solutions that can lead to increased immunization coverage rates. This was the case in Pakistan, where as detailed by Andersson *et al.* [4], researchers addressed the challenge of low measles coverage rates in Lasbela district by introducing an intervention involving an evidence-based and structured series of ***community discussions of vaccination's costs and benefits***. The effect of this intervention was tested using a randomised controlled trial without relying on improved health services. In fact, through this operational research the team, working with communities and health workers, doubled the odds of measles vaccination uptake (20% increase) and tripled the odds of completing full DPT vaccination (29% increase) for this district. The Pakistan study thus provides evidence on how to improve the demand side of vaccination uptake at a relatively low cost (US$9 per child). Interestingly, the work in Mali by Koumaré *et al.* [19] and in Burkina Faso by Sanou *et al.* [12] similarly underscore the need to give priority to *providing information to communities* on the goals of immunization as well as the importance of tailoring interventions to local realities to improve immunization uptake.

The evidence also points to the fact that improving coverage rates requires work not only on the demand side, but also on ***the supply side***. As noted by Andersson *et al.* [4] in discussing the low efficacy rate of measles vaccine in Lasbela, Pakistan, improving service quality is needed to improve efficacy rates. As part of improving supply, the article by Djibuti *et al.* [20] focuses on health care providers and immunization managers in Georgia, documenting the effects of "supportive" supervision on the performance of the immunization program at the district level. Not surprisingly, within a framework of national immunization programs, such provider-based interventions can have a positive effect on coverage.

Finally, the last piece of evidence to help turn around the *fallacy of coverage* comes from the work by Haddad *et al.* [17], which focuses on ***system-related factors*** to explain disparities in immunization coverage among districts in Burkina Faso. By looking at a combination of factors (such as donor support, staffing standards, local strategies, immunization days and leadership by the district medical officer (DMO)) and their interaction, the authors conclude that the key is the ***"human factor"*** and the ability of ***good leadership*** to create the conditions for good performance. Even with limited access to donor supported initiatives or the presence of seasonal epidemics, with strong and committed leadership districts can adapt and perform well. Local strategies, as also demonstrated in the other studies, are also important and become more effective when linked to strong DMO leadership.

Concluding comments

The articles are organised according to geography and research teams, starting in India and ending in Burkina Faso. Though, clearly the evidence repeats itself from South Asia to West Africa. Through locally based operational research, the story of the *fallacy of coverage* is revealed. Timeliness of immunization, social and gender inequities, vaccine efficacy, understanding demand side issues to tailor interventions, and national data sets masking actual district level coverage rates are the key theme areas of evidence. As part of the story, and to turn around the *fallacy of coverage*, the studies also provide proof of effective and locally relevant solutions: introducing structured series of community discussions on the cost-benefit of immunization, the role of supportive supervision and the role of strong leadership.

And such is the story of the *fallacy of coverage*, from South Asia to West Africa. The challenge now is how to build on the strength of the results and translate the evidence to global and national policies, programs and funding. This journal supplement is one step in that direction. At the same time, and as detailed by Duclos *et al.* [6], funding for improving immunization focuses not only on increasing coverage, but also on future diseases and vaccines. While it is important to keep an eye on future diseases, there is strong evidence – to which this supplement contributes – for the need to maintain and increase support to address ***existing*** vaccine-preventable diseases. While overall improvements in global coverage rates are undoubtedly taking place, in 2002 alone, it is estimated that 1.5 million children in all age groups died from diseases preventable by vaccines currently recommended by WHO (excluding measles) [21]. In

addition, disparities persist not only between countries and regions, but also within countries and districts. Thus, the question arises on how best to allocate funds to increase coverage such that by 2015 we can achieve 90% national vaccination coverage and reach the MDG of reducing mortality rates among children under five by two-thirds. The results from the operational research grants of the CIII2 offer some answers by demonstrating how locally generated evidence can inform immunization strategies to ensure that children who need to get vaccinated will get vaccinated, and vaccinated on time. We are making progress, however we still have a way to go.

List of abbreviations used

MDG – Millennium Development Goal; DPT – Diphtheria, Pertussis and Tetanus; CIII2 – Canadian International Immunization Initiative Phase 2; GHRI – Global Health Research Initiative; IDRC – International Development Research Centre; CIDA – Canadian International Development Agency; CIHR – Canadian Institutes of Health Research; HC – Health Canada; PHAC – Public Health Agency of Canada; BCG – Bacille Calmette-Guérin; OPV – Oral polio vaccine; DMO – District Medical Officer.

Competing interests

The authors declare they have no conflicts of interest.

Acknowledgements

The views expressed in this preface are solely those of the authors and do not represent the views of the IDRC.

We would like to thank the GHRI and all its partner agencies – IDRC, CIDA, CIHR, HC and PHAC – for funding, creating and implementing the CIII2 operational research grants, including this journal supplement. We also wish to thank the members of the CIII2 subcommittee, who provided invaluable scientific advice and support throughout the entire CIII2 process (Garry Aslanyan, CIDA; Bhagirath Singh, CIHR; Ingrid Sketris, CIHR; Christina Zarowsky, IDRC; Paul Varughese, HC; and Geoff Black, CIDA). In addition, we would like to thank the Grants Administration Division at IDRC, particularly Mano Buckshi and Pascale Bruneau, for their constant support throughout this initiative and during the creation of this journal supplement. Thank you also to Aku Kwamie and Riswana Soundardjee for assisting in the beginning as the supplement was being formed. From BioMed Central, we are grateful for the support by Ros Dignon in the development of this supplement. Finally, special thanks to the 16 external reviewers who agreed to be part of this important initiative, and without whom this journal supplement would not have been possible.

This article is published as part of *BMC International Health and Human Rights* Volume 9 Supplement 1, 2009: The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants. The full contents of the supplement are available online at http://www.biomedcentral.com/1472-698X/9?issue=S1.

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Opinion

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Global immunization: status, progress, challenges and future

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from The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants

Published: 14 October 2009

BMC International Health and Human Rights 2009, **9**(Suppl 1):S2 doi:10.1186/1472-698X-9-S1-S2

This article is available from: http://www.biomedcentral.com/1472-698X/9/S1/S2

Abstract

Vaccines have made a major contribution to public health, including the eradication of one deadly disease, small pox, and the near eradication of another, poliomyelitis. Through the introduction of new vaccines, such as those against rotavirus and pneumococcal diseases, and with further improvements in coverage, vaccination can significantly contribute to the achievement of the health-related United Nations Millennium Development Goals. The Global Immunization Vision and Strategy (GIVS) was developed by WHO and UNICEF as a framework for strengthening national immunization programmes and protect as many people as possible against more diseases by expanding the reach of immunization, including new vaccines, to every eligible person. This paper briefly reviews global progress and challenges with respect to public vaccination programmes.

The most striking recent achievement has been that of reduction of global measles mortality from an estimated 750,000 deaths in 2000 down to 197,000 in 2007. Global vaccination coverage trends continued to be positive. In 2007 most regions reached more than 80% of their target populations with three doses of DPT containing vaccines. However, the coverage remains well short of the 2010 goal on 90% coverage, particularly in the WHO region of Africa (estimated coverage 74%), and South-East Asia, (estimated coverage 69%). Elements that have contributed to the gain in immunization coverage include national multi-year planning, district-level planning and monitoring, re-establishment of outreach services and the establishment of national budget lines for immunization services strengthening.

Remaining challenges include the need to: develop and implement strategies for reaching the difficult to reach; support evidence-based decisions to prioritize new vaccines for introduction; strengthening immunization systems to deliver new vaccines; expand vaccination to include older age groups; scale up vaccine preventable disease surveillance; improve quality of immunization coverage monitoring and use the data to improve programme performance; and explore financing options for reaching the GIVS goals, particularly in lower-middle income countries.

Although introduction of new vaccines is important, this should not be at the expense of sustaining existing immunization activities. Instead the introduction of new vaccine introduction should be viewed as an opportunity to strengthen immunization systems, increase vaccine coverage and reduce inequities of access to immunization services.

Introduction

Vaccination has made enormous contributions to public health, including the eradication of one dreaded disease, small pox, and elimination of poliomyelitis from all but a handful of countries. It is estimated that between two and three million child deaths are averted annually through vaccination against diphtheria, tetanus, pertussis and measles and many more future deaths averted in older groups (e.g. 600,000 future deaths prevented annually through hepatitis B vaccination). However, vaccine-preventable diseases are still responsible for about 25% of the 10 million deaths occurring annually among children under five years of age [1]. This is partly related to the fact that an increasing number of infectious diseases can now be classified as vaccine-preventable. With the availability of new vaccines, such as those against rotavirus and pneumococcal diseases, and further improvements in vaccination coverage, a much larger proportion of children can now be protected against a broader range of infectious diseases. Thus vaccines have the potential to make a significant contribution to the achievement of the health-related United Nations Millennium Development Goals (MDG), especially MDG4 [2] that calls for a two third reduction in the under-five mortality rate by 2015 compared to 1990 levels. However, if the trend in mortality reduction observed between 1990 and 2005 continues, the goal will not be achieved [3]. The cost of such a failure would be close to 40 million children deaths.

In 2005, the 58th World Health Assembly, recognizing the role that vaccines and immunization can play in reducing under-five mortality, welcomed the Global Immunization Vision and Strategy (GIVS) 2006–2015 developed by WHO and UNICEF as a framework for strengthening national immunization programmes [4,5]. Its goal is to protect as many people as possible against more diseases by expanding the reach of immunization to every eligible person and ensuring that immunization is high on every health agenda. The strategy aims to increase, or at least sustain, very high levels of vaccine coverage, not just for infants but for all age groups, introduce new vaccines and link immunization with the delivery of other health interventions. This strategy was drawn up against a background of increasing demand for vaccines, rapid progress in developing new vaccines and technologies, continuing health-sector development, increasing vulnerability to pandemics and other health emergencies and more potential opportunities for partnerships.

The purpose of this paper is to briefly review global progress and challenges with respect to public vaccination programmes.

Progress

Success of measles mortality reduction efforts

In 2003, the World Health Assembly urged full implementation of the WHO–UNICEF strategic plan for measles mortality reduction 2001–2005 [6], and, at the end of 2005, the major public health goal of reducing global measles mortality by 50% compared with the 1999 level had been surpassed, with a reduction of 60% [7]. In 2005 the World Health Assembly endorsed a revised goal to reduce global measles deaths by 90% by 2010 (or earlier) compared with 2000 as one of the GIVS goals [4]. Global mortality due to measles was reduced by 74% from an estimated 750,000 deaths in 2000 to 197,000 in 2007 [8]. The largest percentage reduction in estimated measles mortality during this period occurred in the Eastern Mediterranean (90%) and African regions (89%), accounting for 79% of the global reduction in measles mortality. Immunization coverage estimates produced annually by WHO and UNICEF, based on official data reported by member states and other published data, showed that in 2007, global coverage with the scheduled dose of a measles-containing vaccine reached 82%, increasing from 72% in 2000 [9,10]. The decrease in measles mortality was the result of both improved routine coverage and the implementation of mass vaccination campaigns. These public health accomplishments helped to prevent nearly 11 million measles deaths between 2000 and 2007, with vaccination campaigns in which more than 578 million children aged nine months to 15 years were vaccinated against measles between 2000 and 2007

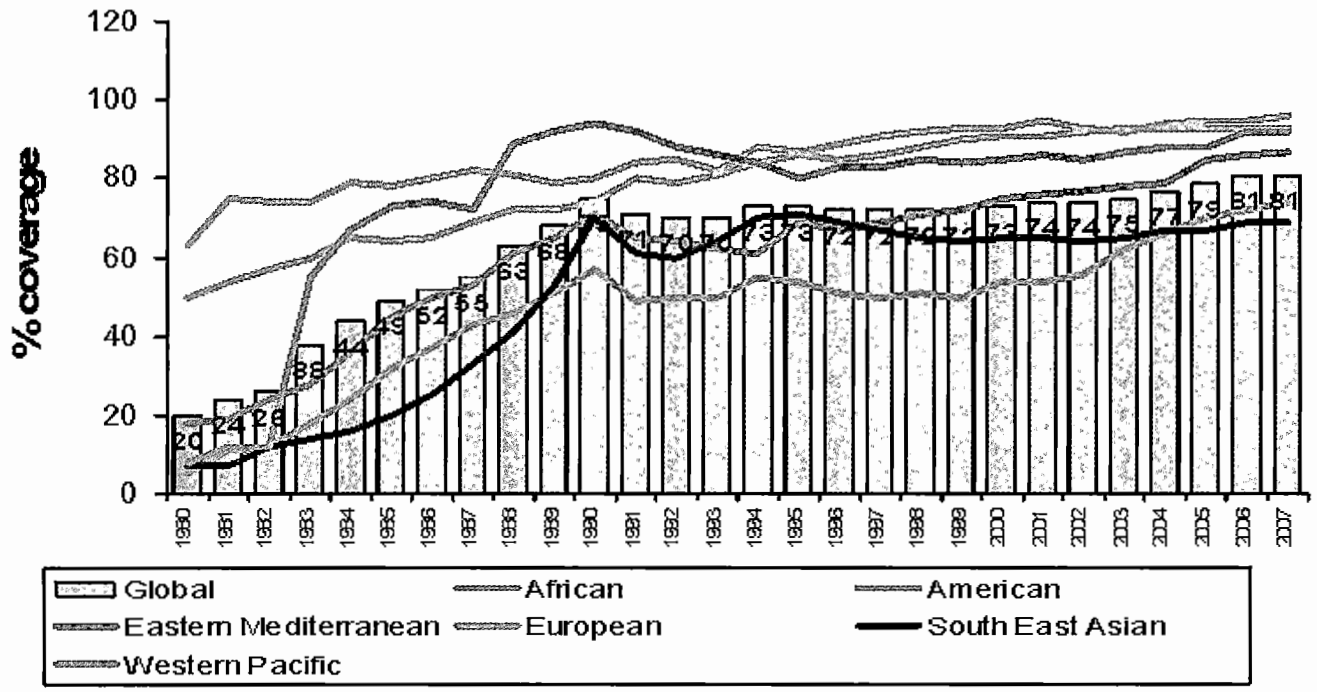

Figure 1 - Global immunization 1980-2007, DTP3 coverage by WHO region.
Source WHO/UNICEF coverage estimates 1980-2007, August 2008, 193 WHO Member States.

in 47 high-priority countries accounting for 3.6 million of these deaths averted. [8] They were made possible by the enormous efforts made by the national governments of the targeted priority countries with the highest disease burden and the concentrated focus of immunization partners on the most effective strategies to control measles rapidly, supported by predictable financing of the programme.

Though there has been tremendous success in reducing measles mortality, deficiencies in routine immunization coverage are threatening to offset these gains with outbreaks occurring in regions with low routine immunization coverage e.g. in Democratic Republic of Congo, Nigeria, Tanzania and Uganda [8]. This also suggests that the achievements are still fragile.

All countries have implemented a measles mortality reduction strategy, except India. India's failure to implement a strategy would mean that the region may not achieve the 90% mortality reduction goal, thus also affecting the achievement of the global measles mortality reduction goal [8].

Progress with routine immunization

Less striking than the success with measles mortality reduction, but equally important, have been overall improvements in routine immunization coverage since 2000. These have been most marked in lowest-income countries, and particularly in sub-Saharan Africa; other regions, apart from South-East Asia, have continued to sustain high levels of immunization coverage. In 2007, out of the estimated 129 million annual surviving infants, a record 105 million children under one year of age were vaccinated worldwide with three doses of diphtheria, tetanus and pertussis (DTP3) vaccine, and the number of unvaccinated children decreased to 24.1 million (11.5 million of which in South East Asia and 7.3 million in Africa) compared with 33.6 million in 2000 [11]. An estimated 86% of the unimmunized children live in countries eligible for funding from the GAVI Alliance and 75% live in just 10 countries in Africa and Asia. These countries include India with close to 10 million unimmunized children, Nigeria, China, Indonesia, as well as Bangladesh, the Democratic Republic of the Congo, Ethiopia, Niger, Pakistan and Uganda. This is due to the large number of children born in these countries and/or low vaccination coverage.

Trends related to global vaccination coverage (as measured by estimates of delivery of DTP3) continued to be positive in 2007, as shown in Figure 1 with most regions sustaining estimated levels of coverage in excess of 80%. The African region reached a record high vaccination coverage level of 74%, while estimates for South-East Asia indicate coverage increasing to 69% yet far away from the

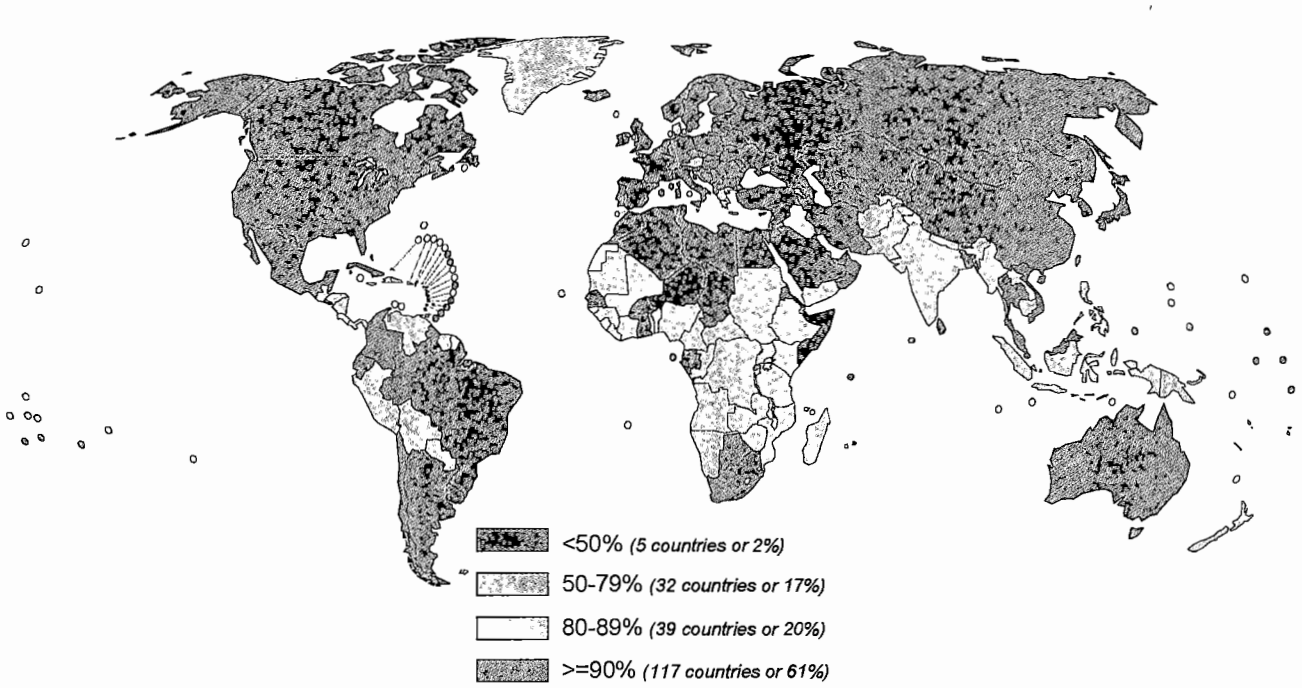

Figure 2 - Immunization coverage with DTP3 vaccines in infants, 2007.
Source: WHO/UNICEF coverage estimates 1980-2007, August 2008, 193 WHO Member States. The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement.

80% mark [11]. In a few countries, however, interruption in immunization services resulted in an actual decline. A total of 117 (61%) countries reached 90% or more DTP3 coverage in 2007 while 156 (81%) reached a DTP3 coverage of 80% or more (Figure 2) [11]. It must be noted, however, that little progress has been achieved towards all countries ensuring at least 80% vaccination coverage in every district or equivalent administrative unit (i.e. one of the GIVS goals based on equity) and only 44 of the developing countries (28%) report DTP3 coverage ≥ 80% in all districts (Figure 3). Indeed, focusing only on average coverage at global or country levels may hide variability among countries and within countries among districts. Reaching unreached children remains one of the major challenges for many developing countries.

Elements that are believed to have contributed to the gain in immunization coverage include national multi-year planning, district-level planning and monitoring, and the establishment of national budget lines, funded with domestic and external resources, including those provided by the GAVI for immunization services strengthening. As a result, routine immunization coverage, seemingly in stagnation since the early 1990s, now shows an encouraging rising trend, particularly in several countries of sub-Saharan Africa.

The district planning and monitoring approach promoted by WHO is based on five key strategies that were initially repackaged in western Africa into a single strategy, which has since rapidly gained acceptance globally as the "reaching every district" (RED) strategy. As an example, with this strategy, vaccination coverage of children in Ethiopia with a third dose of DTP vaccine improved in 14 of the worst performing districts, from an average of 35% in 2002 to 71% in 2005. An evaluation of the RED strategy in nine countries in the region concluded that outreach services had contributed to increased coverage in districts where the strategy was implemented. However, lack of adequate transport facilities remained a limitation to sustaining outreach services [12]. The strategy has now been implemented to various degrees in 53 developing countries, mostly in Africa and south and south-east Asia [13].

The strategy of child health days, led by UNICEF, has also helped to promote routine immunization. Consistent

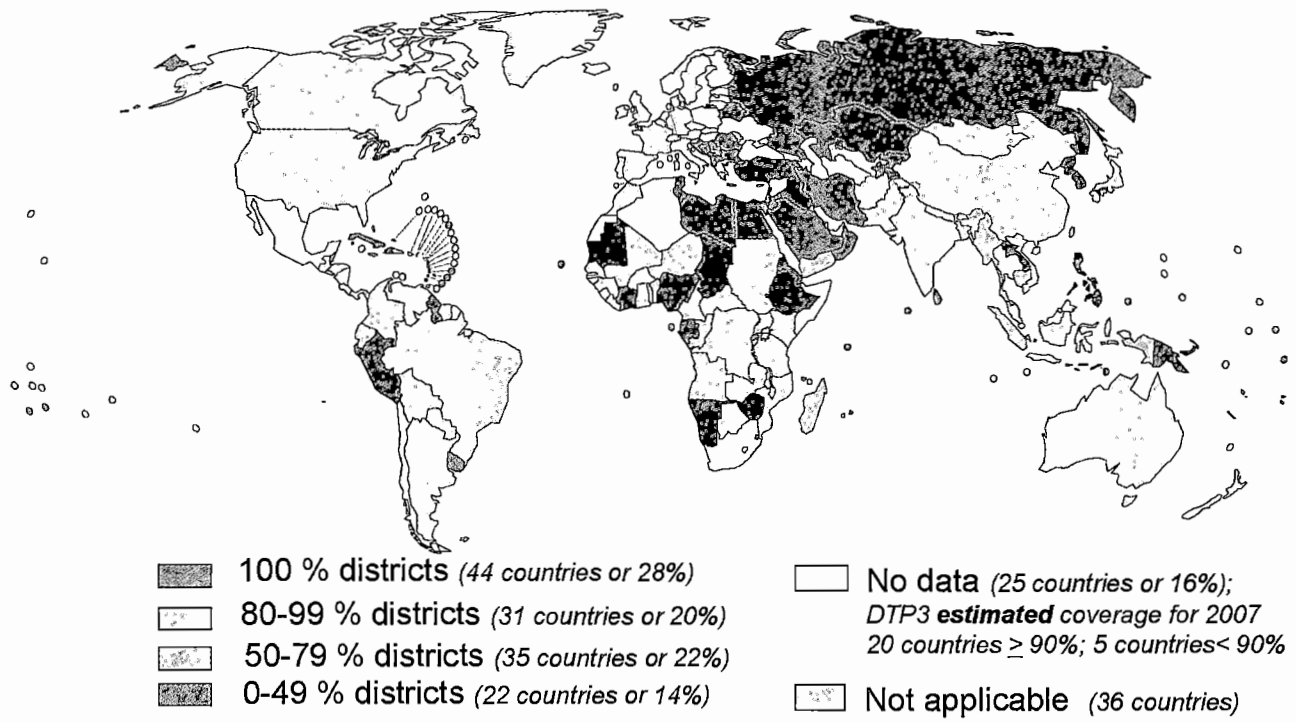

Figure 3 - Countries with % of districts achieving at least 80% DTP3 coverage, 2007.
The boundaries and names shown and the designations used on this map do not imply the expression of any opinion whatsoever on the part of the World Health Organization concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. Dotted lines on maps represent approximate border lines for which there may not yet be full agreement. © WHO 2008. All rights reserved.

with the emphasis of the GIVS on linking immunization with other health interventions, child health days are regular events designed to deliver an integrated package of preventive services such as immunization, vitamin A supplementation, deworming, growth monitoring and distribution of insecticide-treated bed nets. Of the 25 priority countries conducting measles supplementary immunization activities in 2006, 20 (80%) integrated at least one other child-survival intervention with measles. For example, in 2006 approximately 21 million insecticide-treated bednets were distributed during measles campaigns [14]. Child health days which became routine in many African countries, have achieved high coverage and have been shown to reduce inequalities in access to basic health services. They are usually conducted twice a year and the integrated package that they offer is defined according to epidemiological needs and local circumstances. Preliminary analysis of experience so far in Ethiopia, Uganda and the United Republic of Tanzania shows that child health days have helped to deliver multiple interventions effectively (including immunization), to improve routine immunization coverage, and to reduce operational costs per child reached. In contrast to other health programmes, successful implementation of immunization programmes in Africa has resulted in high rates of vaccination coverage in most countries.

Vaccination weeks to promote immunization coverage using new and existing vaccines are regularly organized in the Region of the Americas and the European Region. Endorsed by all Member States in the Region of the Americas in 2003, vaccination weeks have already reached more than 200 million children and adults in that Region, especially in difficult-to-reach populations, isolated communities and towns with low immunization coverage [15]. During the second European Immunization Week in April 2007, 25 Member States in the European Region were involved, underlining the importance of immunization through workshops, debates, training courses, exhibitions and media events [16].

New and underused vaccines

The 2003 State of the World's Vaccines and Immunization has emphasized the inequity in access to new vaccines that increased over the last decades as new life-saving vaccines became available at prices that most low-income

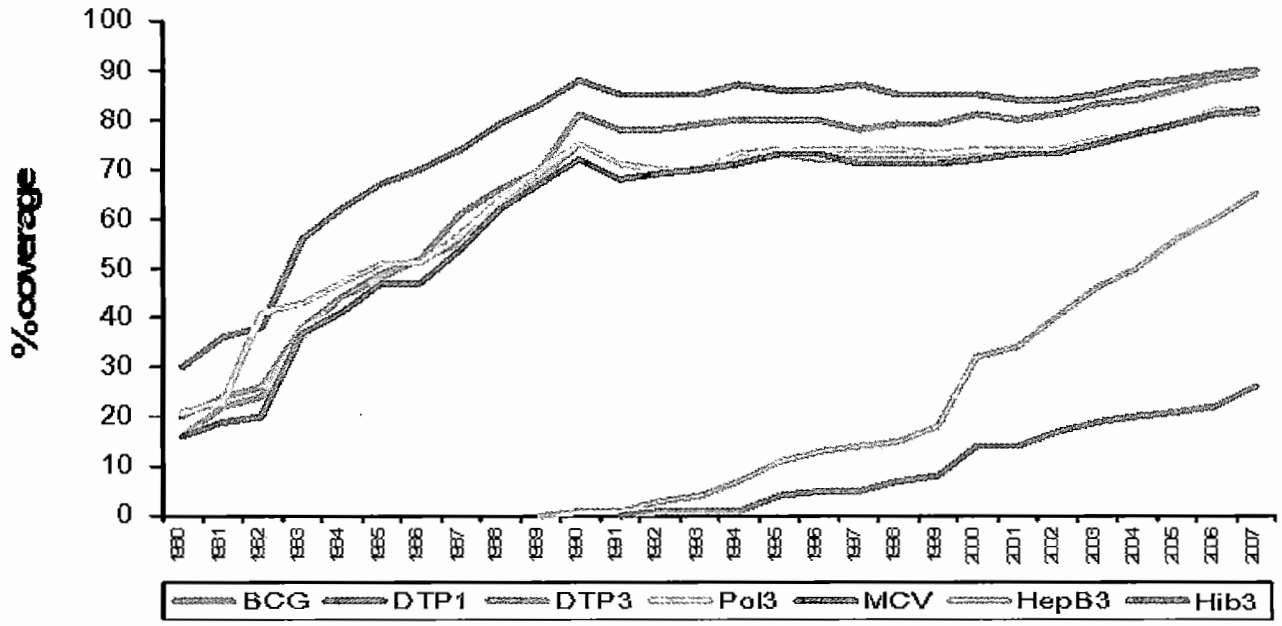

Figure 4: Global coverage estimates from selected vaccines, 1980-2007.
BCG (1 dose) , DTP (3 doses), Measles containing vaccine (1 dose), Hepatitis B (3 doses) and Hib (3 doses).
Source: WHO/UNICEF coverage estimates 1980-2007, August 2008, 193 WHO Member States.

countries were unable to afford [17]. Additional factors such as inadequacy of disease surveillance, inter alia, are also contributing to the North South divide with 12 childhood vaccines routinely used in established market countries and only six in most developing countries. Since that time, the introduction of new and underused vaccines has made and continues to make progress. By the end of 2007, 171 (of which two in part of the country) member states had introduced hepatitis B vaccine into their routine immunization programme compared to 31 Member States in 1992, the year of the World Health Assembly resolution recommending global vaccination against hepatitis B [18]. Global coverage with three doses of hepatitis B vaccine was then estimated at 65% (Figure 4) and is as high as 88% in the WHO Region of the Americas, in contrast to 69% in the African Region and 30% in the South-East Asian Region. This has to do with the lack or partial introduction of hepatitis B vaccination in large population countries. One hundred and seventy eight (92%) member states introduced hepatitis B vaccination by the end of 2008. However, whereas much progress has been made with the routine use of hepatitis B vaccine, this has taken 15 years since the World Health Assembly recommended its universal use. A similar time lag is unfortunately being experienced with *Haemophilus influenzae* type b (Hib) vaccine, for which global coverage remains low at 26% in 2007 (Figure 4). WHO recommends, that in view of their demonstrated safety and efficacy, conjugate Hib vaccines should be included in all routine infant immunization programmes [19]. A previous WHO recommendation encouraged vaccine use only in countries where burden was demonstrated and this may have limited vaccine introduction particularly in the Asian region where the burden was once debated. One hundred and thirty five states (70%) introduced Hib vaccination by the end of 2008 and a further nine countries are expected to introduce the vaccine before the end of 2009. Hib vaccine uptake is highest in the Americas (91% with three doses of Hib). This reflects, in great part, the support from the Pan American Health Organization (WHO Regional Office for the Americas) Revolving Fund [20]. This pooled procurement mechanism has helped supply nearly 40 countries with a range of affordable quality vaccines and syringes for over 30 years. Sri Lanka was the first country in the WHO South-East Asia region to introduce Hib vaccine as of January 2008. In 2007, a record number of countries applied to the GAVI for Hib vaccine introduction. Projections from GAVI applications suggest that by the end of 2009, more than 50% of children living in countries eligible for GAVI funding support will have access to Hib vaccines.

These developments are accompanied by member states increasing uptake of newly licensed vaccines against rotavirus diarrhoea and human papillomavirus infection and of the pneumococcal conjugate vaccine. The fast progress in introducing new vaccines has been facilitated

by member states' growing recognition of the value of the protection conferred by vaccines and immunization. Such progress has also been made possible by the establishment of global financing mechanisms, including the GAVI, and the important role played by regional procurement mechanisms, for example the Revolving Fund for Vaccine Procurement in the Region of the Americas.

Rotavirus vaccine is now in use in 14 countries (two with partial introduction); five additional countries are expected to have introduced the vaccine by the end of 2009 with GAVI support (WHO/IVB database on new vaccine introduction, as of 31 May 2009). This marks the first time that the introduction of a vaccine has occurred simultaneously in both developed and developing countries.

By the end of 2008, pneumococcal conjugate vaccine was in universal use in 21 countries (four with partial introduction). Another 17 countries have plans to introduce the vaccine between 2009 and 2012. In March 2007, WHO published a position paper encouraging countries with high child mortality to consider introducing pneumococcal conjugate vaccines into their national immunization programmes (WHO/IVB database on new vaccine introduction, as of 31 May 2009) [21]. On April 24, 2009, Rwanda became the first GAVI-eligible country to introduce pneumococcal conjugate vaccine.

Further efforts needed and challenges

Indeed, both coverage expansion to reach the never/unreached with traditional Expanded Programme on Immunization vaccines and the addition of a number of new vaccines available by 2012 are critical elements of the GIVS. In spite of progress, however, much remains to be done if the full potential of immunization is to be exploited in achieving the health-related MDGs. About 1.1 million deaths of children under the age of five could be prevented through immunization with new vaccines against pneumococcal disease and rotavirus diarrhoea. In addition, vaccines against human papillomavirus infection could prevent nearly 250,000 annual deaths of women from cervical cancer.

More vaccines will soon become available on a large scale for use, among others, against meningococcal diseases, Japanese encephalitis and typhoid [22-24]. In addition, governments, multilateral agencies, foundations, and research institutions, among others, have substantially increased their investment in the development of new vaccines. As a result, various new vaccines are likely to be available for introduction in the next 10 years. These include, in particular, vaccines against dengue, tuberculosis and malaria. However, countries increasingly have to decide which of these life-saving tools they should finance and use on a routine basis.

The introduction of new vaccines poses challenges to the existing logistics and cold chain requirements due to their current presentations. In particular, the high volume of the pre-filled glass syringe presentation of the 7-valent pneumococcal conjugate vaccine is exceeding the central cold chain storage capacity of some countries and the safe use and disposal of used glass syringes and needles poses a waste management challenge. These issues are being addressed through assistance to countries to improve vaccine and waste management and through interaction with industry to seek more suitable formulations and presentations of new vaccines. Many activities are also ongoing in the area of surveillance of diseases targeted by new vaccines including enhanced laboratory networks and centres of excellence.

WHO and its immunization partners have identified a set of activities to accelerate the introduction of new life-saving vaccines. WHO maintains a global new and under-utilized vaccines action plan, which provides a platform for coordinating the activities of global partners related to the introduction of vaccines in countries that need them most. Decisions on implementing new and underutilized vaccines require scientific evidence and data, a reliable supply of affordable vaccines, which are adapted to the country's immunization schedule, and an integrated disease monitoring and surveillance system. Work has begun on the implementation of this action plan, including the development of strategic options to support the introduction of more expensive new vaccines in low middle-income countries.

The GIVS provides the countries with the opportunities to also implement other strategies for expanding the benefits of vaccines to older age groups, either to complement disease control achieved by infant immunization (i.e. catch up vaccination of adolescents against hepatitis B or administration of booster doses of other vaccines to increase the duration of protection) or to target diseases that occur in older age groups, like human papillomavirus seasonal influenza, and typhoid.

In setting the future agenda two other points deserve attention. First is the need to develop integrated strategies, whereby immunization is implemented as one element of a comprehensive approach to disease control, be it meningitis/pneumonia control, diarrhoeal diseases control, cancer control or epidemic/pandemic prevention and control. Second, the delivery of routine immunization must be seen by all as the basis and the foundation of immunization programmes and must be given attention and dedicated resources. Indeed, reaping the full potential of immunization and including the full benefit of new vaccines can only occur with increasing overall protection and reducing coverage inequities.

Overall national vaccination coverage figures may mask local inequities and challenges. It is also essential that one looks at age-appropriate immunization for all antigens separately and not only at the proportion of children fully immunized by a certain age. Understanding the reasons for the lack of or delayed vaccination and finding innovative ways to reach the unreached and expand immunization to include older age groups to deliver new vaccines or booster doses is essential and operational research is needed to this effect. In this context, one can only applaud the multifaceted and geographic range of research efforts undertaken under the aegis of the Canadian International Immunization Initiative Phase 2 (CIII2) Operational research grants and reported in this supplemental issue [25-37]. These research projects have provided information on what needs to be better understood at a local level when health workers are trying to increase coverage in order to tailor their immunization programming: a) perception of childhood illness and what households see as appropriate time to vaccinate; b) gap in decision making at household level and vaccination process; c) vaccination procedures set by health services; d) who are those that are not completely vaccinated and why; e) role of religion in the decision to vaccinate or not and how often, etc. They also provided evidence on the impact of gender in relation to age-appropriate immunisation.

To be successful in the future, we must tackle the technical, logistics, political and social obstacles that are impeding progress. At global level, we learn that evidence-based policies and well-designed strategic direction are critical factors in guiding the choices of countries and their partners. Since 1974, WHO has facilitated global consensus, commitment and cooperation among several partners, on vaccines standards, immunization policies and strategic direction in support of developing countries.

Internationally, WHO provides recommendations via three main groups: (1) the Strategic Advisory Group of Experts (SAGE); (2) the Global Advisory Committee on Vaccine Safety (GACVS); and (3) the Expert Committee on Biological Standardization (ECBS) [38].

Since 1999, SAGE for immunization gathers some of the best world experts in the field of vaccines and immunization and provides policy and strategic advice to WHO. SAGE was restructured in 2005 to meet the needs of the GIVS and now reports to the WHO Director-General, reviews and approves all WHO policy recommendations, including the WHO position papers on vaccines. These are summaries of information about licensed vaccines of public health interest which are based on an extensive review and ranking of evidence by experts, and inputs from interested parties and industry. They are designed to be used by immunization and public health officials to make decisions about the public health value and use of specific vaccines in regions and countries. Recently SAGE helped to clarify WHO's position on the global use of Hib vaccine, thus facilitating the work of the GAVI Hib vaccine Initiative in support of country level decision-making. Over the past couple of years, SAGE made recommendations to WHO on the use of pneumococcal conjugate, rotavirus and typhoid vaccines, to mention a few, which were used to develop WHO related position papers [21,24,40].

Recommendations need to be adapted to each country. Their aim is not to prescribe rigid immunization schedules that all programmes must follow, but rather to offer a framework which countries can adapt to existing schedules and local epidemiological, economical and other circumstances and in the context of other health priorities. Supporting the establishment/strengthening of National Immunization Technical Advisory Committees that can convert global policy recommendations into a national policy is one of WHO's priorities. This is part of the process to ensure evidence-based decision at country level, which is particularly needed in view of the complexity of the immunization programs and cost of new vaccines [40].

The GACVS was established to respond promptly to vaccine safety issues of potential global importance. The committee does not directly determine immunization policies, but it does express its scientific opinion on vaccine safety, which could result in policy changes. The committee evaluates questions of vaccine safety by thoroughly reviewing the latest developments in basic science, epidemiology and clinical practice. All aspects of vaccine safety are covered, whether of national or international interest. The impartiality of the committee is essential and explains why its mandate is distinct from that of SAGE. The committee has on occasion found the alleged harmfulness of certain vaccines to be unsubstantiated, yet has also promptly recognized, when the need has arisen, the link between a given vaccine and adverse effects [41].

The WHO ECBS was established to set norms and standards for the manufacturing, licensing and control of biologicals. The committee provides guidelines on vaccine manufacturing, quality control, product labeling, transportation and storage, and makes recommendations on assays and other tests of vaccine quality, safety and immunogenicity [38].

Finally, the prequalification is the procedure that WHO has established to assess the acceptability, in principle, of vaccines for purchase by UN agencies. The pre-qualification process was originally codified in 1989, and was

revised in 1996 and 2002 [42]. In addition to UN agencies, many countries now use the list of WHO pre-qualified vaccines to select reliable and high quality vaccines.

Securing adequate and affordable vaccine supply as well as long-term predictable funding for vaccines and immunization is one of the top priorities of the global community in support of the world's poorest people.

For 117 middle and low-income countries, the related cost has been estimated to be $76 billion for vaccines and delivery systems for routine immunization, mass campaigns for accelerated disease control initiatives and new vaccines introduction [43]. The need for accelerated introduction of new vaccines in all high-burden countries must be matched by adequate financial support, including support for countries with lower-middle incomes. Such countries are not eligible for funding from the GAVI and support for them has heretofore been insufficient or lacking. As a result, these countries are starting to face increasing financial and technical challenges in order to maintain the same levels of access to newer technologies as low-income countries, which benefit from financial and technical assistance from sources such as the GAVI Fund. Limited access to international support is resulting in lower-middle income countries beginning to lag behind the poorest countries in protecting their populations from vaccine-preventable diseases using newer vaccines and combination vaccines. The current global financial crisis will unfortunately make the overall financing of the immunization programmes even more challenging.

To meet the above challenges and reach the immunization objectives already expressed in the United Nations General Assembly special session on children (2002) and further enunciated in the GIVS, strong disease surveillance and programme monitoring systems are required. WHO and its partners have developed a global framework for vaccine preventable disease surveillance and immunization programme monitoring [44]. This framework combines the use of countrywide active surveillance, passive aggregate disease reporting, sentinel site surveillance, and prospective, time-limited projects to generate the comprehensive epidemiological data required to guide immunization programmes. It also outlines strategies such as ongoing monitoring of vaccine management and vaccine safety, as well as cross-sectional programme reviews to assess the state of programmes at the district and health facility levels.

Continuous measurement of vaccination coverage is key to assessing programme performance and also taking timely corrective action. Ideally, coverage monitoring should be based on accurate and timely reporting of administrative data that is reported up from the most peripheral levels to the national, regional and global levels. The data should be used at the different administrative levels for timely corrective action when the data indicate gaps or failures in the programme. Population-based surveys and data quality audits serve to validate the coverage estimates. The WHO-UNICEF joint reporting format on national immunization performance collects annually information from 193 member states and has been an important source for global monitoring of immunization performance [45]. While in most countries, the coverage estimates based on administrative data reported by countries are validated by surveys, in some countries wide discrepancies between coverage estimates based on administrative data and coverage surveys still exists. Efforts are ongoing to provide such countries with support to determine the sources of error in the administrative coverage data and take corrective action [46,47].

As has been demonstrated by the global poliomyelitis eradication initiative, efficient surveillance systems can be established, even in resource-poor settings, at quite low cost relative to the cost of the intervention itself. The poliomyelitis surveillance network provides a structure for rapidly detecting and responding to diseases of national and international importance. Where appropriate, this network should serve as the platform both for an integrated disease surveillance system that provides epidemiological data on other communicable diseases, and for detection and response to emerging infectious disease threats. Funding for disease surveillance is usually disease specific and time limited. In the presence of weak national systems, parallel systems tend to be established in order to generate data suited to the needs of specific programmes. These uncoordinated efforts may address short-term needs, but are unsustainable in the long term. The global framework provides an opportunity for immunization partners to coordinate their efforts to secure sustainable funding for surveillance and programme monitoring.

Developments in vaccines and immunization provide us with tremendous opportunities to impact the health of our populations, particularly the health of poor and marginalized communities who carry the disproportionate burden of disease. This opportunity comes with big challenges for weak health systems. GIVS provides a framework for maximizing the benefits of vaccination, but also creating efficiencies through an integrated and synergistic approach to health care delivery.

List of abbreviations used

BCG – Bacille Calmette-Guérin; DTP – Diphtheria, Tetanus, Pertussis; GAVI – GAVI Alliance; GIVS – Global Immunization Vision and Strategy; MDG – Millennium

Development Goals; RED – Reaching Every District; SAGE – Strategic Advisory Group of Experts; GACVS – Global Advisory Committee on Vaccine Safety; ECBS – Expert Committee on Biological Standardization; CIII2 – Canadian International Immunization Initiative Phase 2.

Competing interests

The authors declare that they have no competing interests.

Acknowledgements

This article is published as part of *BMC International Health and Human Rights* Volume 9 Supplement 1, 2009: The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants. The full contents of the supplement are available online at http://www.biomedcentral.com/1472-698X/9?issue=S1.

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Gender inequity and age-appropriate immunization coverage in India from 1992 to 2006

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from The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants

Published: 14 October 2009

BMC International Health and Human Rights 2009, **9**(Suppl 1):S3 doi:10.1186/1472-698X-9-S1-S3

This article is available from: http://www.biomedcentral.com/1472-698X/9/S1/S3

Abstract

Background: A variety of studies have considered the affects of India's son preference on gender differences in child mortality, sex ratio at birth, and access to health services. Less research has focused on the affects of son preference on gender inequities in immunization coverage and how this may have varied with time, and across regions and with sibling compositions. We present a systematic examination of trends in immunization coverage in India, with a focus on inequities in coverage by gender, birth order, year of birth, and state.

Methods: We analyzed data from three consecutive rounds of the Indian National Family Health Survey undertaken between 1992 and 2006. All children below five years of age with complete immunization histories were included in the analysis. Age-appropriate immunization coverage was determined for the following antigens: bacille Calmette-Guérin (BCG), oral polio (OPV), diphtheria, pertussis (whooping cough) and tetanus (DPT), and measles.

Results: Immunization coverage in India has increased since the early 1990s, but complete, age-appropriate coverage is still under 50% nationally. Girls were found to have significantly lower immunization coverage ($p<0.001$) than boys for BCG, DPT, and measles across all three surveys. By contrast, improved coverage of OPV suggests a narrowing of the gender differences in recent years. Girls with a surviving older sister were less likely to be immunized compared to boys, and a large proportion of all children were found to be immunized considerably later than recommended.

Conclusions: Gender inequities in immunization coverage are prevalent in India. The low immunization coverage, the late immunization trends and the gender differences in coverage identified in our study suggest that risks of child mortality, especially for girls at higher birth orders, need to be addressed both socially and programmatically.

Abstract in Hindi: See the full article online for a translation of this abstract in Hindi.

Abstract in Hindi

See Additional file 1 for a translation of the abstract to this article in Hindi.

Background

In India there is a well-documented history of son preference [1-4]. A growing body of literature has examined the impacts of India's son preference on child survival, juvenile sex ratio, and the numbers of 'missing' women [5-10]. There is evidence that the son preference in India and other South Asian countries contributes to disadvantage in women's health throughout the life course [11]. Disadvantage for girls in India begins with a reduced chance of being born at all, and those who are born face lower access to preventive care and treatment of disease compared to boys [6,11,12].

Girls born in India have a 40% greater risk of ill health compared to boys and are less likely to access health care, in particular immunization [11,13,14]. Boys, however, are more likely than girls to die in the first month of life from perinatal conditions, such as birth asphyxia and birth trauma. Only two other conditions (unintentional injuries and congenital anomalies) are more common among boys than girls. Beyond these causes, and contrary to the trends observed in most of the world, in India more girls than boys die of acute respiratory diseases, infectious and parasitic diseases, and viral infections [15,16].

Many of the deaths among India's children are avoidable, including those from the childhood cluster of vaccine preventable diseases (especially measles and tetanus), malaria, diarrhoea caused by organisms such as rotavirus, and acute respiratory infections caused by *Streptococcus pneumonia* and *Hæmophilus influenza* type b (HiB). Recent data shows that immunization – long established worldwide as a highly cost-effective lifesaver – still reaches only a minority of India's children, even after the substantial improvements in vaccination coverage against measles and polio. To make matters worse, girls are especially vulnerable due to inequities in access to immunization coverage [17].

Preference for sons in India has been noted to vary across regions, levels of fertility, and order of birth [1,18-20]. A wide variety of studies have examined the affects of India's son preference on child mortality and India's sex ratio in light of changing fertility patterns and concern for 'missing' women. Less research has focused on the influence of India's son preference on gender inequities in access to health care, specifically immunization, and how this may have varied with time and across regions. In this article we investigate the presence of gender inequities in terms of access to timely immunization coverage. We will focus on trends in gender inequities at the national level, by birth order, and by state of residence using data collected from 1992 to 2006.

Previous research

Inequities in immunization coverage by gender have been shown to exist throughout India [12]. Of the 17 major states, 10 have demonstrated inequity in full immunization coverage against girls. Even states that perform well in immunization coverage struggle with considerably different immunization rates between boys and girls [20]. A search of available literature yielded several studies reporting lower immunization coverage among girls as compared to boys. A study of more than 4000 rural Indian children in 1993-1994 indicated that fewer than 55% of children were fully vaccinated and that girls had a 5% lower coverage compared to boys [17]. In 1992, Bonu et al evaluated vaccination coverage among children aged 12-35 months before and after a three-year government vaccination-awareness program in rural areas of four north Indian states. Prior to the program, girls were found to be at a disadvantage compared to boys and the differences in coverage by gender persisted following the program's completion [21]. Other studies reviewed indicated lower immunization coverage for girls compared to boys, although differences were non-significant [22,23].

We compiled data from these four studies comprising nine sub-samples (based on a combination of different age groups and antigens) to obtain an overall ratio of coverage (girls vs. boys). We observed an overall coverage ratio estimate of 0.93 (95% CI: 0.90, 0.9, Figure 1) – indicating that among these studies girls were 7% less likely to be immunized when compared to boys ($p<0.001$).

Methods

Data sources

This study uses data from three consecutive rounds of the Indian National Family Health Survey (NFHS) [24-26]. The International Institute for Population Sciences coordinated each round of the survey with support from several international organizations. The three cross-sectional surveys were conducted during 1992-93, 1998-99 and 2005-06. A summary of the coverage and target population for each round is presented in Table 1. The sampling, questionnaire structure, and content of the NFHS surveys follow what has been adopted by the Demographic Health Surveys (DHS) in other developing countries. The NFHS uses nationally representative area-based sampling frames in each survey [27]. The NFHS produced high response rates in all states. Details of the survey methodology and response rates have been published for each round of the survey [24-26].

Sample for analysis

Our sample for analysis includes all children below five years of age with complete immunization histories (N = 121,100). The 1998-1999 survey only included children up to 35 months of age at the time of the survey. About

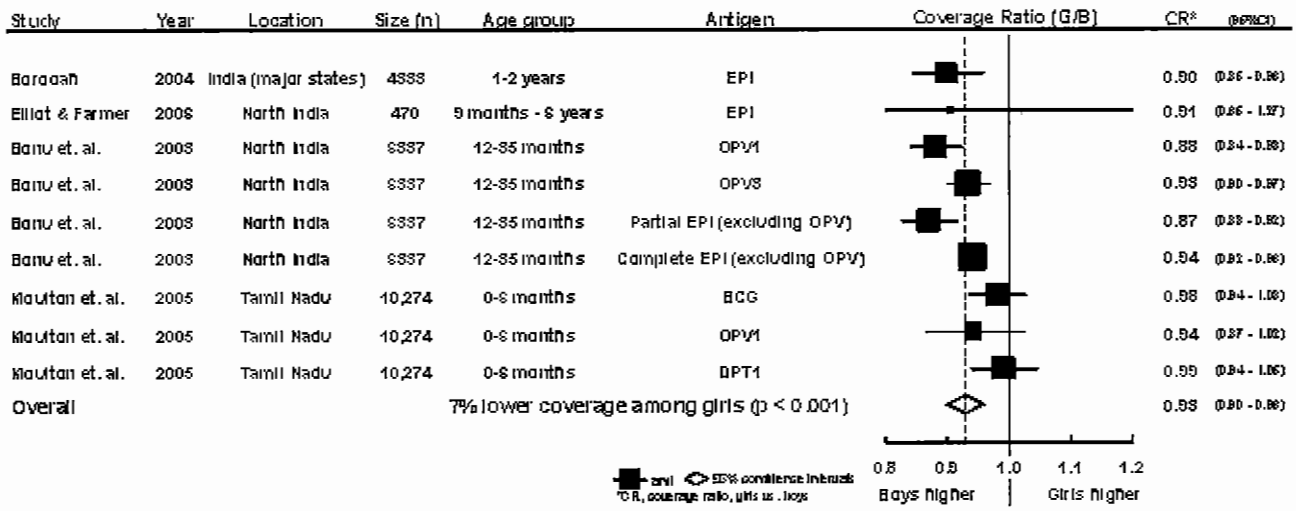

Figure 1 - Girl-to-boy ratios of immunization coverage and combined estimates derived from previously published studies.

The girl-to-boy immunization coverage ratios are based on the results of studies where data was available for calculation of pooled estimates. A CR of less than 1.0 indicates higher coverage in favour of boys.

Table 1 - Overview of India's National Family Health Survey (NFHS).

	Survey Phase		
	1992-1993 (NFHS-1)	1998-1999 (NFHS-2)	2005-2006 (NFHS-3)
Sample size (women)	89,777	91,000	230,000
Age group (women)	13-49	15-49	15-49
Data collection period			
Start	April 1992	Nov 1998	Dec 2005
Finish	Sept 1993	Dec 1999	Aug 2006
Number of states	25	26	29
Living cohorts	1988-1993	1996-1999	2001-2006
Total sample (living children under 5)	45,275	30,821	48,468
Sample included in analysis	43,732	29,669	47,709
Reference period for immunization coverage			
Start	Jan 1988	Jan 1996	Jan 2001
Finish	Aug 1993	Dec 1999	Aug 2006

3% of children were excluded due to missing data on immunization coverage. Total sample sizes of children under five along with analysis samples for each round of the NFHS are detailed in Table 1.

Indicators and measures

We defined immunization coverage as up to date, age-appropriate immunization coverage. Standard indicators of immunization coverage are based on the percentage of children who have accumulated the required number of vaccines by a certain age, regardless of timeliness. Age-appropriate vaccination has been shown to be an important component of infection control [28,29] by reducing transmissibility in susceptible populations [30,31] and by increasing the probability of survival [32]. We determined age-appropriate immunization coverage for each antigen using a combination of data from the child's immunization card and maternal recall when cards were unavailable. Previous studies have demonstrated that maternal recall can be a robust estimation of immunization coverage in settings where complete records are not available [33].

Immunization information was available for the following antigens: bacille Calmette-Guérin (BCG), oral polio vaccine (OPV), diphtheria, pertussis (whooping cough) and tetanus (DPT) vaccine, and measles vaccine. We considered children age-appropriately immunized if they had received all immunizations for their age according to the WHO's Expanded Program on Immunization (EPI) immunization schedule. Modelled on the WHO guidelines, the government of India's Universal Immunization Program (UIP) was introduced in 1985 and includes one dose of BCG (at birth), three doses of OPV and DPT (at 6, 10, and 14 weeks), and one dose of measles (at nine months) [34]. India's EPI/UIP schedule used for our age-appropriate classification is detailed in Figure 2.

Using the child's age in months and the EPI schedule, a composite binary variable indicating EPI complete (yes or no) was created to represent the overall age-appropriate immunization status of each child as follows:

0-1 month: child was considered age-appropriately immunized (EPI=1) if they had received BCG;

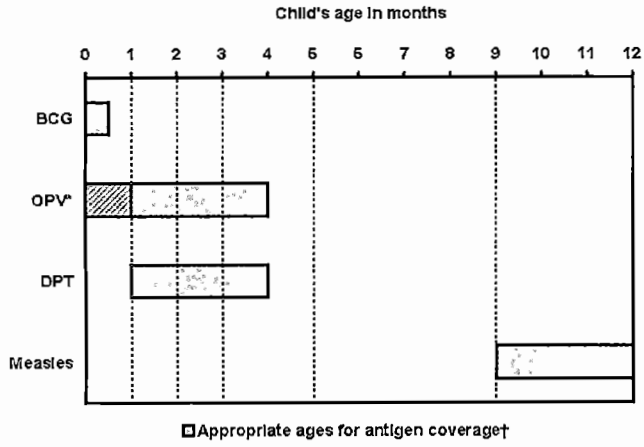

Figure 2 - Recommended expanded program of immunization (EPI) schedule for India.
*OPV-0 is an additional dose of polio given at birth, but is not part of India's national immunization program. †Dashed lines indicate ages (1,2,3,5, and 9 months) used in determining appropriate immunization coverage within the child's first year. Children were considered to have age-appropriate EPI coverage if they had received all antigens recommended for their age.

2-3 **months:** child was considered age-appropriately immunized (EPI=1) if they had received BCG and two doses of OPV and DPT (one dose of OPV and DPT if aged two months);

4-8 **months:** child was considered age-appropriately immunized (EPI=1) if they had received BCG and three doses of OPV and DPT;

9 **months and older:** child was considered age-appropriately immunized (EPI=1) if they had received BCG, three doses of OPV and DPT, and one dose of measles.

To study the influence of birth order and gender of the older siblings, we calculated the birth order and gender of each child in relation to the birth order and gender of their siblings. In a subset of children for whom the complete date of birth (day, month, and year) was known and complete date of immunization was recorded on the immunization card, we calculated age of vaccine receipt for all EPI antigens.

Data analysis

The analyses in this paper are primarily descriptive and present gender differences in immunization coverage by antigen, birth order, year of birth, and state across the three rounds of the NFHS survey. Using the composite EPI age-appropriate variable, we examined gender differences in coverage by birth order and sibling composition. We also examined the change in age-appropriate coverage by birth cohort (based on year of birth) for each EPI antigen. Births that occurred near to the time of the survey are excluded from the cohort analyses in order to prevent underestimates of coverage due to reduced opportunity to receive complete immunizations among these children. We instead report proportion of children not immunized for these birth cohorts. Gender differences in immunization coverage are presented at the state and national level. Sampling weights were used for all analyses. We tested differences between proportions using *t* statistics. Data were managed and analyzed using Stata (version 10) statistical software [35].

Results

Gender inequities in age-appropriate immunization coverage

Immunization coverage has increased in India since 1992-1993 (Figure 3), but age-appropriate EPI coverage remains below 50% nationally for both boys and girls. Coverage of OPV has improved substantially according to the 2005-2006 data, but progress has not been as marked for DPT and Measles.

At the national level, age-appropriate BCG coverage among boys increased from 58.2% (95%CI 57.4; 59.0) in 1992-1993 to 76.0% (95%CI 75.3; 76.7) in 2005-2006. BCG coverage for girls increased from 54.9% (95%CI 54.1; 55.7) in 1992-1993 to 73.1% (95%CI 72.3; 73.8) in 2005-2006. Differences in BCG coverage between girls and boys indicate that girls still have lower access to BCG at the national level ($p<0.001$, in all three periods).

The percent of boys with age-appropriate OPV coverage increased from 50.1% (95%CI 49.3; 50.8) in 1992-1993 to 78.7% (95%CI 78.1; 79.4) in 2005-2006 and from 47.0% (95%CI 46.2; 47.8) in 1992-1993 to 77.5% (95%CI 76.8; 78.2) in 2005-2006 for girls. The most dramatic increase in age-appropriate OPV coverage has happened between 1998-99 and 2005-2006, but comparison of the coverage for boys and girls at the national level still shows significantly lower OPV coverage ($p=0.012$) among girls.

Coverage of DPT has shown less improvement. According to the 1992-1993 data, age-appropriate DPT coverage among boys was 48.5% (95%CI 47.7; 49.3), reaching 52.4% (95%CI 51.4; 53.3) in 1998-1999 and climbing only a few percent points in 2005-2006 to 55.7% (95%CI 54.9; 56.5). Coverage for girls has increased from 45.1% (95%CI 44.3; 46.0) in 1992-1993 to 49.8% (95%CI 48.8; 50.7) and to 53.3% (95%CI 52.5; 54.2) in 1998-1999 and 2005-2006, respectively. Girls, however, are experiencing

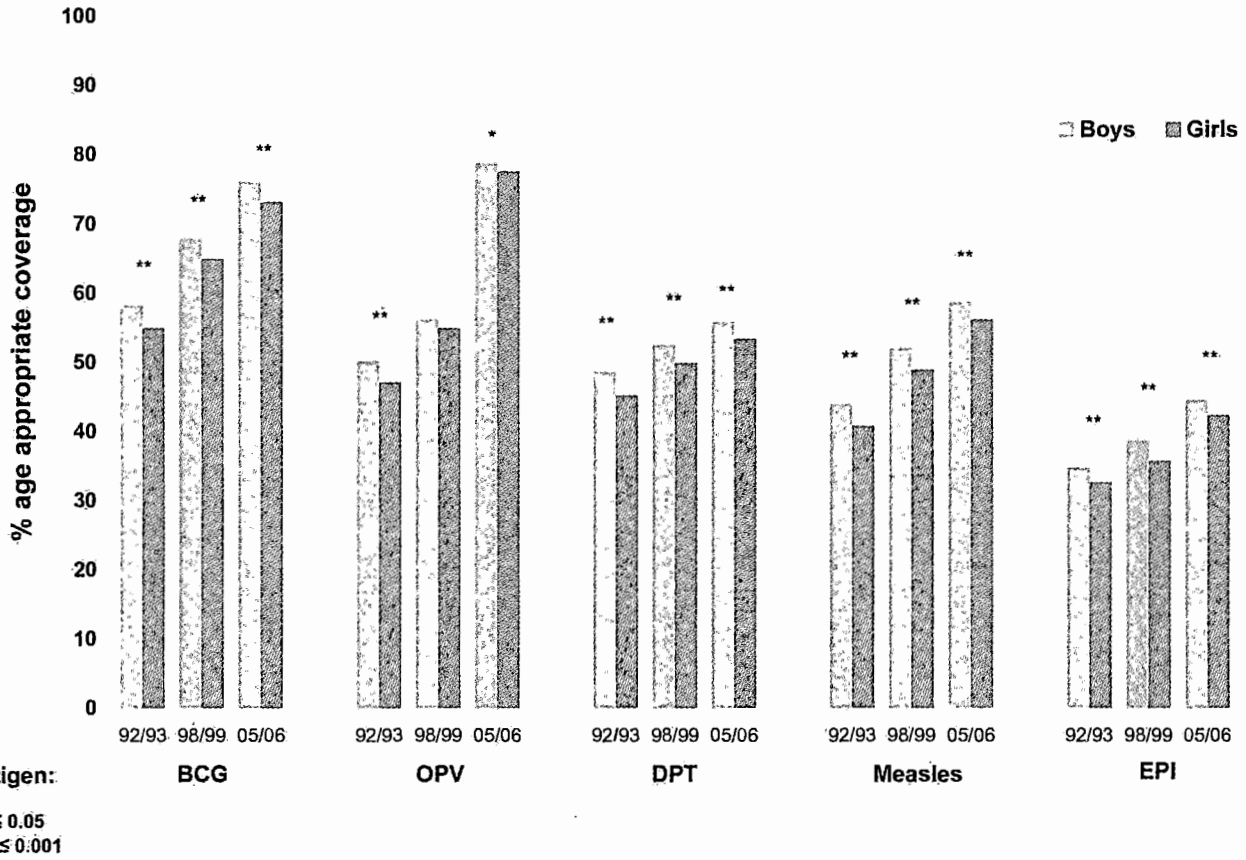

Figure 3 - Percent of children with age-appropriate coverage, by gender, antigen, and date of survey. Period of NFHS Surveys: 92-93 (NFHS 1), 98-99 (NFHS 2), and 05-06 (NFHS 3). Vertical bars represent 95% confidence intervals (CI).

significantly lower coverage rates compared to boys ($p<0.001$, in all three periods).

Measles, an antigen that requires over 95% coverage to stop transmission in a population, still has very low coverage rates in India. For boys, there has been an increase in age-appropriate coverage from 43.9% (95%CI 43.0; 44.8) in 1992-1993 to 58.6% (95%CI 57.8; 59.5) in 2005-2006. Age-appropriate coverage among girls increased from 40.7% (95%CI 39.9; 41.6) in 1992-1993 to 56.1% (95%CI 55.2; 57.0) in 2005-2006. Differences in coverage by gender are still significant ($p<0.05$) with girls experiencing lower coverage than boys. Large increases can still be made in the overall levels of coverage of measles vaccination.

As can be noted from the gender specific coverage rates reported above, gender differences in vaccination coverage are consistent and significant, but do not appear to have increased over time. Girls' coverage for every antigen lags behind boys' coverage in all years, but neither gender displays acceptable age-appropriate coverage levels for any antigen (Figure 3).

Inequities in age-appropriate immunization coverage due to birth order

Birth order and family composition is an important predictor of vaccination coverage. Higher birth order is associated with a lower probability of being age-appropriately immunized. Despite the increase in rates of age-appropriate immunization coverage over time, the gender gap has not been reduced. Girls are much less likely to be up to date with their immunization at any given age. Furthermore, the gap increases with birth order unless a girl has an older brother. Girls who are born third to a family with two other girls are in the extreme of immunization disadvantage, when compared to boys who are born third to families with two older girls. Only 36.1 % (95%CI 33.3; 39.0) of third born girls with two older sisters are appropriately immunized for their age compared to 45.0% (95%CI 42.3; 47.8, Figure 4) of the third order boys with two older sisters. Higher birth order

children (third or higher) with mixed gender sibling (i.e. brothers and sisters) composition have very low age-appropriate immunization coverage, not reaching 30%. Still, girls are experiencing lower coverage rates compared to boys.

This trend is inverted for third order births following two older boys (Figure 4). In this situation, the gender gap is not as pronounced. Like all children at higher birth orders, these children are vulnerable to lower age-appropriate immunization coverage. Indeed, the coverage rates for these children are lower in 2005-2006 than rates observed for first order children born more than 10 years before (i.e. in 1992-1993, Figure 4).

Trends in gender inequities over time

We present trends in age-appropriate immunization coverage by birth cohort and antigen in Figure 5. Age-appropriate immunization by gender is presented for children born during the years between 1988 and 1993, between 1996 and 1999, and between 2001 and 2006 inclusive. For children born during the survey years (1992-93 for NFHS-1, 1997-98 for NFHS-2, and 2005-6 for NFHS-3), we present the proportion of children not age-appropriately immunized in Figure 6.

Age-appropriate coverage of BCG increased over the cohorts analysed for both boys and girls. In the majority of cohorts, girls received lower age-appropriate BCG coverage than boys. This difference remained significant for children born in 2003 and 2004 ($p<0.05$), Figure 5. For children where the date of immunization was recorded, the median age of receiving BCG decreased from 11.3 weeks in 1990 to 7.0 weeks in 1996 and to 4.7 weeks in 2003. For boys the decrease has been from an age of 11.6 weeks in 1990 to 6.7 weeks in 1996 and to 4.6 weeks in 2003. The WHO/EPI recommendation is that BCG be administered at birth or first contact with health services. Our results indicate a considerable delay in BCG coverage for both boys and girls (see web appendix in Additional file 2). The proportion of boys and girls born during the survey years who were not vaccinated are presented in Figure 6. These estimates are cross-sectional and should be interpreted taking into account future opportunity for immunization.

Age-appropriate coverage of OPV has improved from 1988 to 2004 and similar coverage for both boys and girls has been achieved in recent birth cohorts. Where information is available, it is noted that the age of receiving OPV-1 has been reduced from a median of approximately 13 weeks in 1990 (boys and girls) to less than nine weeks in 2003, near to the recommended age of six weeks. The median time to the second and third polio dose remains above the WHO recommendation of 10 and 14 weeks, respectively (Additional file 2). There has been a reduction in median age for receiving OPV-2 from 18 weeks (for all children) in 1990, to 15 weeks in 2003. The median age to receive OPV-3 was 24 weeks for boys and 33 weeks for girls in 1990. This has been reduced to 21 weeks for boys and 27 weeks for girls in 2003. Girls born in 2003 received OPV-3 more than 13 weeks later than recommended.

Important gender inequities in DPT coverage were noted for children born in 1989, 1991, and 1996. These inequities have not persisted for children born in 2001-4 (Figure 5). Overall levels of DPT coverage have, however, remained below 60% for boys and girls. The median age for receiving the first DPT dose was seven weeks later than recommended for girls and boys in 1990. This has reduced to three weeks later than recommended for children born in 2003 (Additional file 2). Boys and girls born in recent years are also receiving the second and third DPT doses earlier (Additional file 2).

There has been an increase in age-appropriate measles immunization coverage for boys and girls born in 2004 compared with children born in 1988. A difference in coverage between girls and boys is still apparent, even for children born in recent years. Girls born in 2004 had significantly ($p<0.05$) lower coverage than boys born in the same year. Both girls and boys continue to receive the measles vaccine about six weeks later than recommended (Additional file 2).

Age at immunization

Across all antigens, the distributions of age at immunization demonstrate significant positive skew (Additional file 2). The children at upper tails of these distributions are being immunized extremely late. This indicates that a sizable amount of children are behind the recommended immunization schedule for all of the evaluated antigens. The median age at immunization appears to be decreasing, suggesting an increase of children being vaccinated on time for those born in recent years. Considerable variability exists in the sample sizes available in each birth cohort due to incomplete data on child's date of birth and/or dates of immunization. There does not appear to be large gender inequities in terms of age at immunization, but a sizeable number of children are behind the recommended immunization schedule for all the evaluated antigens (Additional file 2).

Gender inequities in immunization coverage by state and region in India

Substantial variation in levels of EPI coverage for boys and girls exists between states in India (Figure 7). Immunization coverage was not strongly correlated with gender inequities in coverage (Pearson's $r = 0.06$). Six out

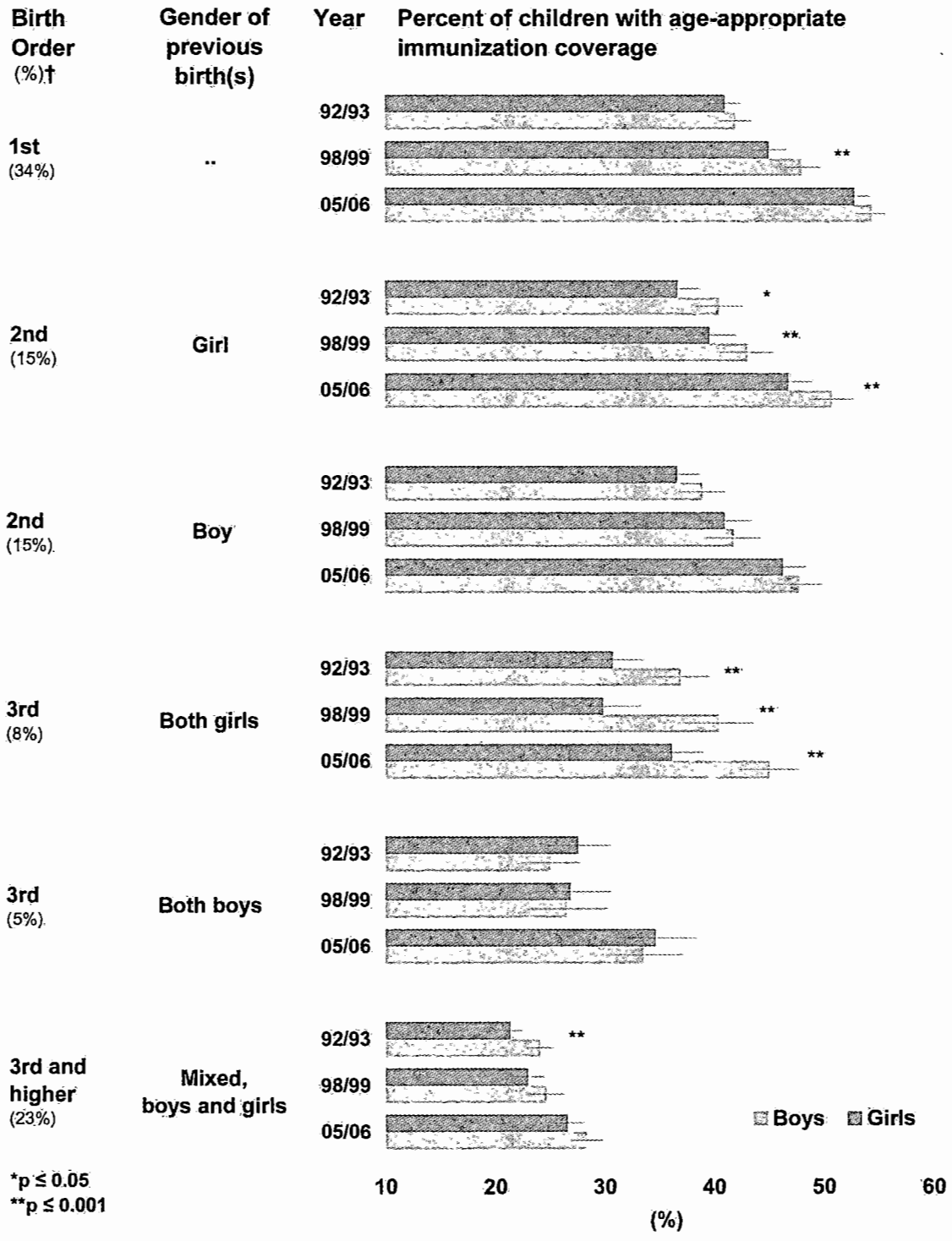

Figure 4 - Percent of children with age-appropriate coverage of EPI vaccines, by birth order, gender of previous birth(s), and survey period.

Overall (EPI) age-appropriate immunization coverage for girls and boys at each birth order (column 1) and sibling gender composition of previous birth(s) (column 2) is represented by the bar chart for each year of the survey period (column 3). †Percentages in brackets (column 1) are the proportion of all births represented by each category of birth order and sibling gender in the 2005-6 survey. Horizontal bars represent 95% CI.

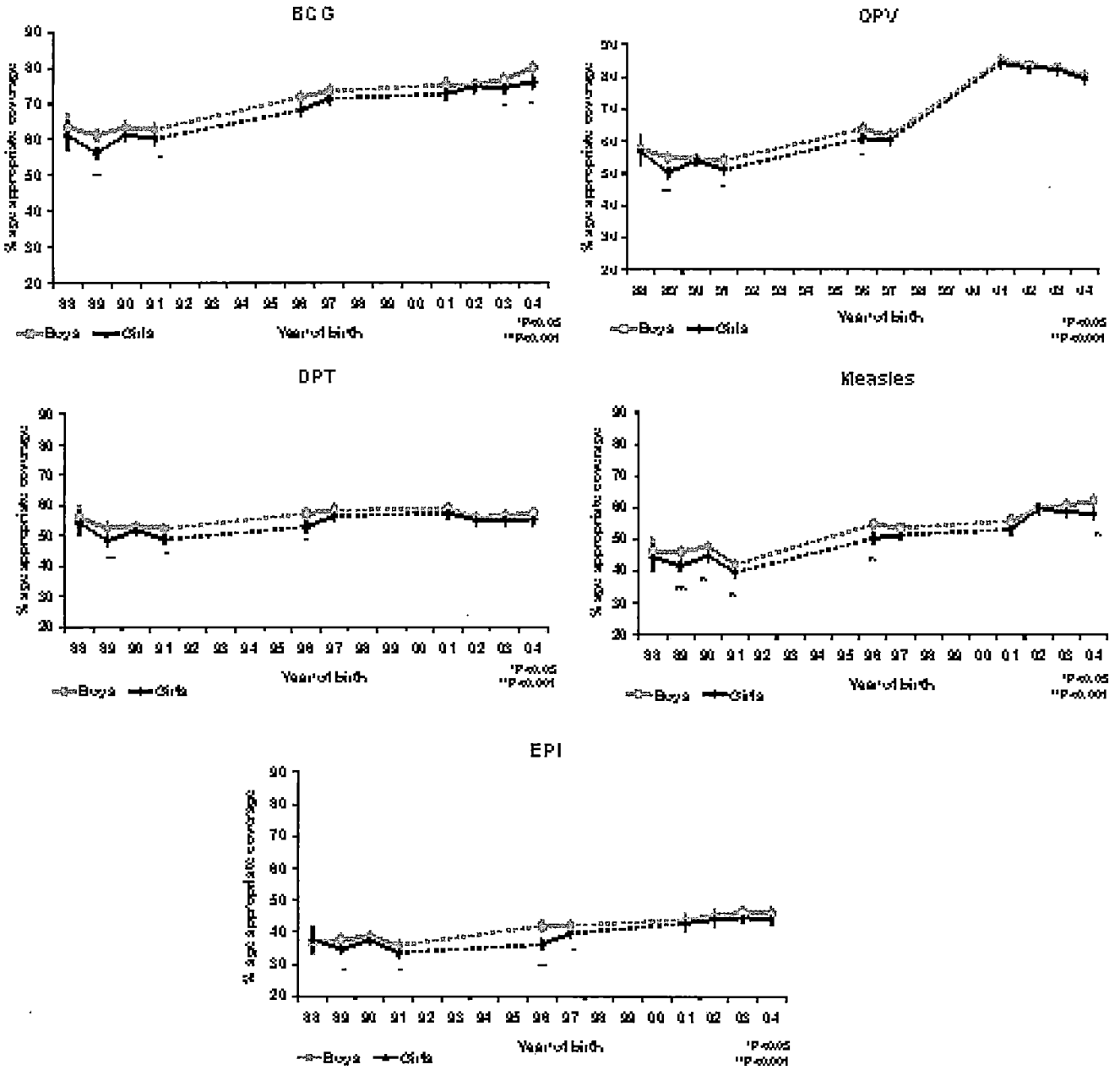

Figure 5 - Trends in age-appropriate immunization coverage of EPI antigens in India by antigen, gender, and year of birth.

Years of birth covered by NFHS surveys are indicated by solid points and lines. Dashed lines indicate periods where data is not available. Vertical bars represent 95% CI.

of the fifteen states that perform above the national average in immunization coverage are also among the eight states with the lowest ratios of girl-to-boy immunization coverage (Figure 7). Nationally, the girl-to-boy ratio of immunization coverage is 0.95 ($p<0.001$), demonstrating that 5% fewer girls than boys are fully immunized.

The three states with the lowest girl-to-boy ratios of immunization coverage are the northern states of Punjab, Haryana, and Bihar. In these states, between 10 and 14% fewer girls than boys are fully immunized. Other northern states, including Uttar Pradesh and Delhi, demonstrate low girl-to-boy coverage ratios (0.92, and 0.93, respectively)

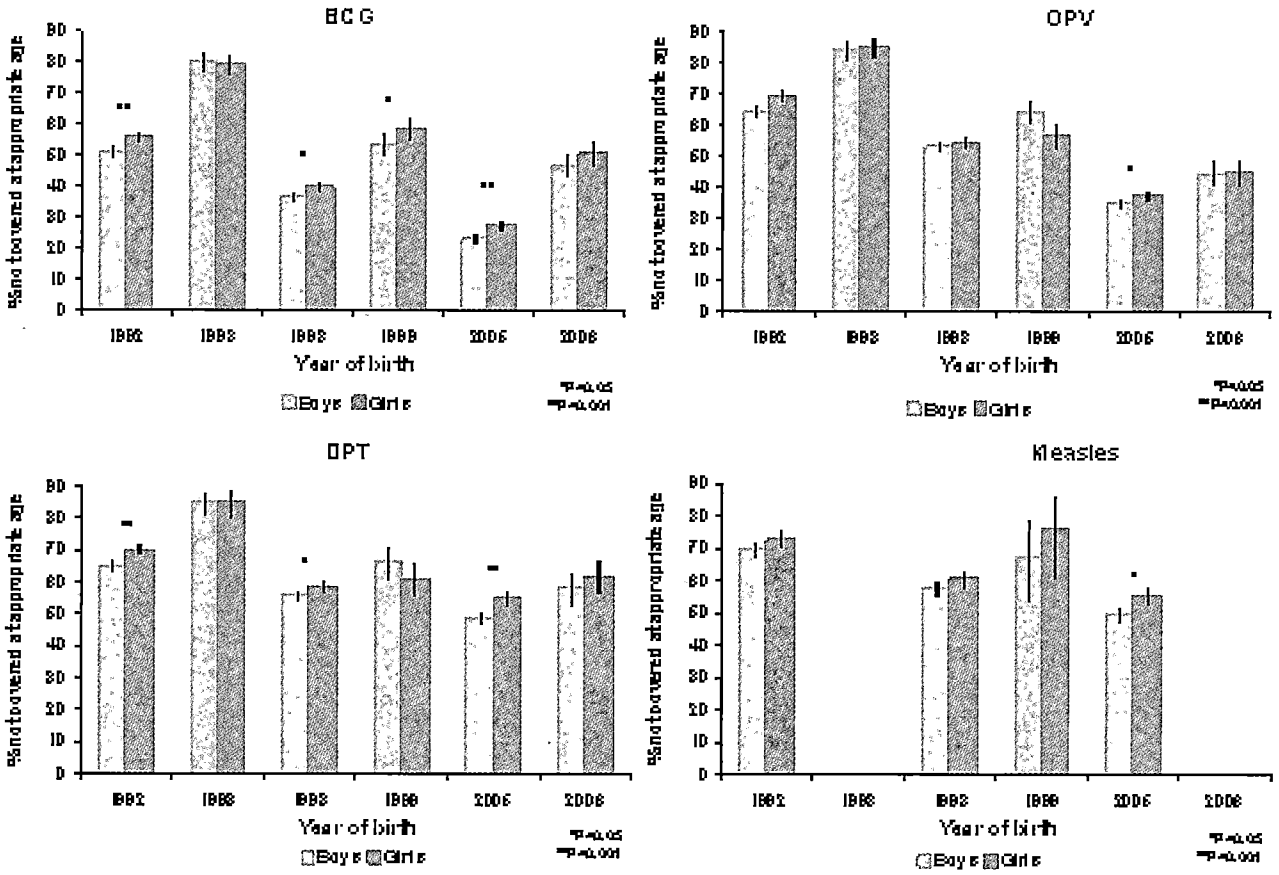

Figure 6 - Percentage of children without age-appropriate immunization coverage in India at the time of each NFHS survey, by antigen and gender.

We calculated the percentage of children born during each survey period who were not appropriately covered for each antigen according to their age. Vertical bars represent 95% CI.

although these differences in coverage are not statistically significant. The southern Indian states of Tamiml Nadu and Keral demonstrate high levels of immunization coverage (80.5% and 75.4%, respectively) and near equity in coverage by gender. Gender inequities in immunization coverage are not clearly determined by a north south divide. Two northern states, Himachal Pradesh and Rajasthan, demonstrate an immunization coverage ratio that favours girls (Figure 7). Additionally, the southern state of Andhra Pradesh demonstrates a large difference in coverage favouring boys (0.93, p=n.s.). The northeastern states of Jharkhand and Assam demonstrate the largest coverage ratios in favour of girls, but are among the states with the lowest coverage rates.

Using proportions of children not appropriately immunized for their age in 2005-6 and population data from the 2001 Census [36], we estimate that, nationally, up to 31M girls and 32M boys aged 0 to four are lacking age-appropriate immunization coverage in India. We present estimated numbers of children lacking age-appropriate coverage for boys and girls aged 0 to four in 21 states in Figure 7. Nationally, and for many states, the absolute number of boys exceeds the number of girls lacking complete age-appropriate immunization coverage. This is due to gender imbalances in India's population structure, leading to fewer girls than boys at these ages [6,36].

Discussion

Using three nationally representative surveys from India, our findings indicate that, at the national level, girls have lower immunization coverage than boys. We noted that girls at higher birth orders and with older sisters are at greater risk of missing antigens compared to boys of the same birth order and sibling gender composition. Analyses of children by birth year revealed consistently lower coverage of BCG and measles for girls compared to boys, while also suggesting that gender inequities in OPV

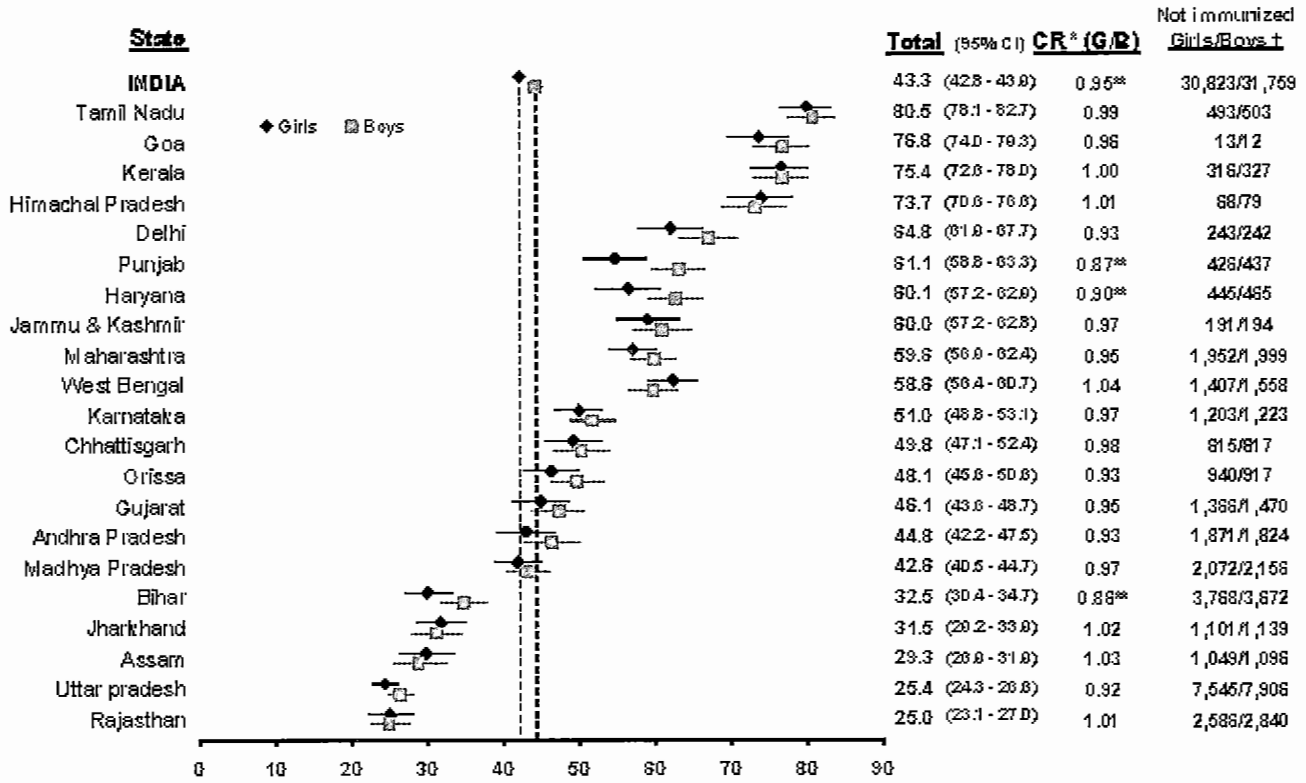

Figure 7 – Percentage of children with age-appropriate EPI coverage, girl-to-boy coverage ratio, and number of children without age-appropriate immunization coverage in India (2005-2006), by state and gender. NFHS 3 data and state-level sampling weights were used for this figure. †Absolue number of children without age-appropriate EPI coverage, estimated from the 2001 Indian Census [34]. *CR, coverage ratio, girls vs. boys **$p \leq 0.001$.

and DPT coverage may have narrowed for children born in recent years. Gender inequity in immunization coverage was found to be greatest in three northern Indian states, consistent with previous findings of strong son preference in these areas [1,7,19]. The gender inequities in access to preventive care in India noted here are likely to reflect, at least in part, the societal preference for sons in India [11,20].

Our estimates are lower than those published in the NFHS reports as these reports do not account for the timeliness of vaccine delivery [24-26]. Analyses of age at immunization indicated minimal differences between girls and boys for all antigens, suggesting a child's gender may affect the decision to immunize, but not timeliness of coverage.

The use of age-appropriate immunization coverage rates as a health indicator can aid in determining the consequences of not receiving timely vaccination. In our analysis, a substantial number of boys and girls were receiving BCG between one and two years after birth. Studies in the US indicate that the timeliness of immunization coverage can have a considerable impact on child survival [37,38]. In Bangladesh, a study revealed timely BCG immunization could reduce the mortality risk up to 40% for children vaccinated between 60 and 180 days of life and up to 80% for children vaccinated within the first 60 days of life [32]. Similar results have been shown for the effect of age-appropriate DPT immunization and the risk of pertussis [39]. Socioeconomic characteristics associated with delayed immunization have been rarely studied in India [40] and further research is needed in this area.

Our finding that gender inequities in immunization coverage are not correlated with overall immunization coverage is consistent with previous studies [12,20]. Several states with low girl-to-boy coverage ratios (e.g. Punjab, Haryana, and Delhi) are performing above the national average in terms of overall coverage. Data from the DHS in India and other South Asian countries indicate that the gender differences in immunization coverage are observed among all socio-economic levels, with some

indication that differences may be larger among the rich than among the poor [12].

Gender inequity in access to health services is believed to be one consequence of larger societal circumstances across South Asia that favour boys and leads to the marginalization of women from a young age [11]. An exploration of socioeconomic and sociocultural determinants of gender inequities in immunization coverage is beyond the scope of this work. Readers are referred to other studies investigating the determinants of gender inequities in sex ratios [6,7], child mortality [5,41,42] fertility patters [1,2], and nutrition [17,20]. Further investigation into the determinants of continuing gender inequities in India's immunization coverage is required.

Along with improved nutrition, immunization is a major tool for saving children's lives, standing out, even in settings of very low income, as a highly cost-effective and efficient intervention [43]. Currently, in India, two-thirds of the children who die of measles and other preventable childhood diseases would have survived if they had had access to immunization. The additional annual per capita cost necessary to reach 90% of Indian children with the six basic vaccines already included in the national immunization program – diphtheria, tetanus, pertussis, TB (BCG), polio, and measles – would be less than three rupees (eight US cents) in the poorest states and even less in wealthier states [44].

Our study shows that current inadequate levels of immunization coverage in India are only part of the problem. Gender inequity in access to health programs is responsible for a considerable number of avoidable deaths. India's states could save even more lives by addressing deep-seated social and cultural issues responsible for gender discrimination at the household level, where girls are seen as a burden and boys as a resource [41]. Campaigns to raise awareness of gender inequities in conjunction with improvement in vaccine delivery strategies with a focus on timeliness of coverage may be a means to that end. Continuing research is needed in order to identify effective social policies of reducing gender inequities in access to immunizations and other health practices across India and other parts of South Asia.

Conclusions

In India, inequities in girls' access to health services have persisted in recent years. Our research has examined this disparity through a study of gender inequities in child immunization coverage. Young girls are especially vulnerable to these gaps in coverage, but efforts need to be made to increase overall immunization coverage for both girls and boys. Over half of children under five are not fully immunized, and a large proportion of those immunized are being immunized too late. These two factors can lead to increased transmissibility of infections, reducing protective effects of immunization and contributing to avoidable child deaths. In 2005, over 60 million children were not appropriately immunized in India.

List of abbreviations used

BCG – Bacille Calmette-Guérin; DHS – Demographic Health Surveys; DPT – Diphteria, Pertussis and Tetanus; EPI – Expanded Program on Immunization; Hib – *Hæmophilus influenza* type b; NFHS – Indian National Family Health Survey; OPV – Oral Polio Vaccine; UIP – Universal Immunization Program.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

DC and DB conducted the literature review, data analysis and drafted the manuscript. PJ, RK, SA, RJ, NK, DB, and DC designed and coordinated the study. All authors participated in the interpretation of the results and reviewing the final manuscript.

Additional material

Additional file 1

Abstract in Hindi.
Available from:
http://www.biomedcentral.com/content/supplementary/1472-698X-9-S1-S3-S1.doc

Additional file 2

Web Appendix: Distributions of time to immunization, by antigen, gender and year of birth.

This web appendix presents the distributions (box and whisker plots) of the time to vaccination for each antigen by year of birth. Boys and girls are presented separately. Dashed red lines indicate time of age-appropriate vaccine administration. Red diamonds indicate the mean time to vaccination. The full data table is also presented. Children born in 1994, 1995, 2000 and 2006 (for measles only), are not covered by the NFHS surveys and no data is presented for these years.
Available from:
http://www.biomedcentral.com/content/supplementary/1472-698X-9-S1-S3-S1.doc

Acknowledgements

This work was carried out with the aid of a grant from the International Development Research Centre (IDRC), Ottawa, Canada, as part of the Canadian International Immunization Initiative Phase 2 (CIII2).This initiative is a project of the Global Health Research Initiative (GHRI). We thank Lukasz Aleksandrowicz for his assistance in the literature review and preparation of the manuscript. We also thank MEASURE DHS for making the NFHS India datasets available.

This article is published as part of *BMC International Health and Human Rights* Volume 9 Supplement 1, 2009: The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants. The full contents of the supplement are available online at http://www.biomedcentral.com/1472-698X/9?issue=S1.

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BMC International Health and Human Rights

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One size does not fit all: local determinants of measles vaccination in four districts of Pakistan

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from The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants

Published: 14 October 2009

BMC International Health and Human Rights 2009, **9**(Suppl 1):S4 doi:10.1186/1472-698X-9-S1-S4

This article is available from: http://www.biomedcentral.com/1472-698X/9/S1/S4

Abstract

Background: Rates of childhood vaccination in Pakistan remain low. There is continuing debate about the role of consumer and service factors in determining levels of vaccination in developing countries.

Methods: In a stratified random cluster sample of census enumeration areas across four districts in Pakistan, household interviews about vaccination of children and potentially related factors with 10,423 mothers of 14,542 children preceded discussion of findings in separate male and female focus groups. Logistic regression analyses helped to clarify local determinants of measles vaccination.

Results: Across the four districts, from 17% to 61% of mothers had formal education and 50% to 86% of children aged 12-23 months had received measles vaccination. Children were more likely to receive measles vaccination if the household was less vulnerable, if their mother had any formal education, if she knew at least one vaccine preventable disease, and if she had not heard of any bad effects of vaccination. Discussing vaccinations in the family was strongly associated with vaccination. In rural areas, living within 5 km of a vaccination facility or in a community visited by a vaccination team were associated with vaccination, as was the mother receiving information about vaccinations from a visiting lady health worker. Focus groups confirmed personal and service delivery obstacles to vaccination, in particular cost and poor access to vaccination services. Despite common factors, the pattern of variables related to measles vaccination differed between and within districts.

Conclusions: Vaccination coverage varies from district to district in Pakistan and between urban and rural areas in any district. Common factors are associated with vaccination, but their relative importance varies between locations. Good local information about vaccination rates and associated variables is important to allow effective and equitable planning of services.

Background

Coverage of childhood vaccination remains low in many developing countries [1], including Pakistan [2]. In order to increase vaccination rates, it is appropriate first to understand the factors related to vaccination coverage and uptake.

The poorest people in developing countries have lower access to and use of health services, including vaccination, than their better off neighbours [3]. There is continuing debate about the relative importance of parental knowledge and attitudes and service delivery factors (including interaction with the population supposed to be served) as determinants of vaccination rates [4]. Some authors stress parental (demand side) factors, including knowledge, attitudes, education and socio-economic status, as important in determining vaccine coverage, either in demanding vaccinations or in accepting the offer of vaccinations [5–9]. Others emphasize the role of delivery of services (supply side); this includes both the knowledge and attitudes of service providers and their interaction with parents, and availability of vaccination services [10–13]. A study in Colombia found the knowledge of vaccinators influenced vaccination rates in their coverage areas [14].

One argument is to increase coverage of vaccination through a technical programme without tailoring to local circumstances [15]. In developed countries with a relatively good vaccination service offer, parental attitudes tend to determine vaccination uptake. But the importance of parental factors is less clear in developing countries, with relatively poor services or restricted access. The determinants of vaccination may also vary with local cultural and other factors, as well as national and sub-national differences in level and quality of services. Understanding the interplay of factors determining vaccination rates in specific locations is important for local planning of programmes to increase vaccination rates.

As part of a process of building capacities for collecting and using local data for planning public services under devolved local government in Pakistan, together with district personnel we undertook representative household surveys in four districts. These included questions about vaccinations of children under five years old, parental knowledge and attitudes, and household socio-economic status. We linked the household information with information about the sample communities and availability of vaccination services. This allowed us to examine the personal and service-related factors associated with vaccination rates in the four districts, with quite markedly different rates of vaccination.

Figure 1 - Map of focus districts.

Methods

A registered ethical review board in Karachi, Pakistan, approved the social audit programme in Pakistan, including the work in the focus districts, in 2004.

Sampling

We selected the four districts purposively for the capacity-building initiative: Khairpur in Sindh province, Haripur in North West Frontier province (NWFP), and Khanewal and Sialkot in Punjab province. They joined our initial focus district of Lasbela in southern Balochistan province [16]. In each district the elected district nazim (mayor) had expressed interest in the district social audit process; in some cases the nazim had approached CIET to request technical support for a district and sub-district evidence-based planning process. The districts were not intended to be nationally or provincially representative.

Khairpur is a conservative district in interior Sindh. Large parts of the east and south of the district are desert areas and arid hills, and the district population is mainly concentrated in the west and north. Haripur is close to Islamabad and relatively liberal by NWFP standards. Much of the district is fertile with easy terrain but, like most of the province, it has few urban communities. Khanewal lies towards the less developed south of Punjab; it relies mainly on agriculture and, although quite densely populated, it has relatively few urban sites. Sialkot is located in the more developed north of Punjab and lies close to the borders with India and Kashmir; it is small, densely populated, and heavily industrialized. The map in Figure 1 shows the location of the four districts, together with the initial focus district (Lasbela).

In each district, we drew a stratified random cluster sample. First, we randomly selected union councils (the lowest administrative unit) from each *tehsil* (sub-district administrative area), reflecting the urban/rural spread in each district, and with the number selected according to the population in each *tehsil*. The official list of union councils provided by the district government was the sampling frame for the selection of union councils. From each union council we randomly selected one community (village or *mohalla*) from the list of communities in the union. In each selected community, the sample included a group of 100 contiguous households with children below five years old, spreading out from a random starting point. There was no sampling within the site; all the eligible contiguous households up to 100 were included.

Instruments

A *household questionnaire* included: questions to a household respondent about demographics and socio-economic status of the household; and questions to mothers or caretakers of children below five years old, concerning their education, knowledge, attitudes and practices, as well as vaccination status of the children. We used well-known local terms for the various vaccinations, and described their timing and administration (e.g. "an injection into the arm" for measles vaccine) to assist mothers' recall; we did not attempt to verify the mothers' reports by checking vaccination cards.

The field team leaders completed *community profiles* by means of discussion with a knowledgeable person in each community and their own observations. Each community profile included information about location of health facilities offering vaccinations and whether vaccination teams visited the community.

A *key informant interview* collected information from lady health workers (LHW) in those sites where they worked, including their education and training, visits to the households, any problems they faced, and their relevant knowledge and practice.

We developed *feedback focus group guides*. These presented the findings from the household survey about the actual vaccination rates in the district and, based on this evidence, invited discussion about the perceived reasons for non-vaccination of children, and about how to encourage and support parents to vaccinate children.

Data collection

Trained field teams from each district, with a majority of female interviewers, undertook data collection during spring and summer 2005. Usually, each team completed the household survey, community profile, and key informant interviews in one community in one day. The field teams took with them a letter from the district government, giving official status to the work. On entering each community, the supervisor explained the purpose of the survey to community leaders and sought their support for the field-work in the community.

After initial analysis of the household findings, which provided evidence about vaccination rates in the district, trained teams returned to the same communities and conducted separate male and female focus group discussions in each community, based on this evidence, using the focus group guides. The participants for the separate male and female groups were drawn from among the households included in the household survey. Each group comprised some 8-12 participants. The trained reporters took notes during the discussions and afterwards, together with the facilitators, prepared reports on the discussions. The focus groups took place in the summer of 2005.

Data management and analysis

Trained operators undertook data entry using the public domain software package Epi Info. Double data entry with validation reduced keystroke errors. Further cleaning of the dataset looked for logical errors, out of range responses and duplications. The cleaning was completed by checking back to the original data registers as necessary.

Analysis relied on CIETmap software [17]. To investigate the relationship between household socio-economic status and important outcomes, we defined a composite binary variable for household vulnerability, as an indicator of socio-economic status. The vulnerability variable was based on household roof construction, degree of overcrowding, and occupation of the main breadwinner. If at least two out of the three factors were adverse, we categorised the household as "vulnerable". We categorized the remaining households as "less vulnerable". Although for each district the sample size in each *tehsil* reflected the relative population in that *tehsil*, this was not exact. Therefore, to take into account under- and over-sampling between *tehsils*, we calculated weights and applied these when making district level estimates. All the district figures presented here are weighted, unless stated otherwise.

We calculated vaccination rates for each district separately, among children aged 12-23 months. Further analysis examined the associations between childhood vaccination, specifically measles vaccination (among children aged 10-59 months), and related risk and resilience factors, first in a univariate analysis and then in a multiple logistic regression analysis, stepping down from an initial saturated model. Explanatory variables included were those related to the outcome in univariate analysis or for which there was prior reason to believe were likely to be

Table 1 - The household sample in the four districts.

	Khairpur	Haripur	Khanewal	Sialkot
Number of households	3249	2017	2400	2275
'Vulnerable' households[a]	51%(1690/3183)	23%(468/1982)	48%(1112/2360)	25% (582/2248)
Households in urban sites	26% (738/3249)	10% (200/2017)	18% (412/2400)	28% (622/2275)
Number of mothers of children under 60 months	3421	2091	2497	2414
Mothers with some formal education	17% (517/3410)	46% (949/2082)	27% (706/2494)	61% (1448/2403)
Number of children <60 months	4739	2682	3586	3535
Number of children 12-23 months	781	512	652	703

[a]The household vulnerability variable is a composite variable intended as an indicator of socio-economic status. The variable is based on three factors: roof construction, crowding, and occupation of the main breadwinner. If two out of the three factors are adverse, the household is categorized as 'vulnerable'.

related to the outcome. Initial sequential stratification revealed that the associations between many of the variables and measles vaccination were different between urban and rural communities and between the four districts. An overall logistic regression model, with stratification by district, showed significant interactions between district and other explanatory variables. We therefore undertook separate logistic regression models for urban and rural communities in each of the four districts: eight models overall. In the logistic regression models, we adjusted the 95% confidence intervals around the Odds Ratios to allow for clustering [18,19]. Each model initially included the same explanatory variables, and variables not significantly related to the outcome in this model were sequentially removed to produce the final most parsimonious model explaining the outcome. The explanatory variables included in all the initial models were: mother has some formal education; household not vulnerable; mother can correctly identify a vaccine preventable illness; mother visited by LHW and told about vaccination; mother has not heard of any bad effects of vaccination; mother has discussed immunisation in the family; mother participates in decision about vaccinating the child; government health facility offering immunisation within 5 km; vaccination team visits the community. We eventually had seven models, because data for urban sites in Haripur were too sparse to allow separate analysis. All urban sites in Khairpur, Khanewal, and Sialkot were within 5 km of a government health facility offering vaccination. We report adjusted Odds Ratios from the final models (taking into account the effects of the other variables in the model), together with the cluster-adjusted 95% confidence intervals around the adjusted Odds Ratios.

Results

Population characteristics and immunisation rates

Table 1 shows some characteristics of the population in the household sample in each district. Using a common definition, there were more vulnerable households in Khairpur and Khanewal than in Haripur and Sialkot. The proportion of urban households was lowest in Haripur, reflecting the overall rural nature of NWFP. Within Punjab, Sialkot (an industrialized district in the north of the province) had a higher proportion of urban households than Khanewal, towards the south of the province. The proportion of mothers with any formal education varied considerably, from only 17% in Khairpur to as high as 61% in Sialkot.

All urban communities were within 5 km of a government facility offering childhood vaccination, except for one of three urban communities in Haripur. Many rural communities were also within this distance (30/70 in Khairpur, 18/28 in Haripur, 25/31 in Khanewal, and 21/28 in Sialkot). Among urban communities, 8/16 were visited by a vaccination team in Khairpur, 1/3 in Haripur, 5/6 in Khanewal, and 7/10 in Sialkot. Among rural communities, visits of vaccination teams were common in Punjab (30/31 communities in Khanewal and 23/27 communities in Sialkot had been visited); visits were less common in NWFP (9/26 communities in Haripur) and Sindh (26/71 communities in Khairpur).

The proportions of children aged 12-23 months reported by their mothers or caretakers to have received different vaccinations are shown in Table 2. In all four districts, the rate of BCG vaccination (the first vaccination) was higher than the rate of the full course of DPT (three doses) and the rate of measles vaccination (the last in the series, given at nine months). Measles vaccination coverage was notably lower in Khairpur and Khanewal than in Haripur and Sialkot. Rates of polio vaccination were high in all districts.

The rates of measles vaccination by sex of the child and in urban and rural communities in the four districts are shown in Table 3. Vaccination rates were slightly higher among boys in all districts. In all districts, measles vaccination rates were notably higher in urban communities. The lowest rate was in rural communities in Khairpur, while very high rates prevailed in urban sites of Haripur and Sialkot.

Table 2 - Immunisation rates in the four districts among children aged 12-23 months.

	Percent (numbers) who received the vaccination			
Vaccination	Khairpur	Haripur	Khanewal	Sialkot
BCG	75 (562/775)	90 (452/506)	82 (526/644)	95 (651/686)
DPT full course (3 doses)	52 (371/757)	85 (428/507)	68 (427/637)	88 (602/686)
Measles	50 (356/737)	80 (396/497)	65 (413/635)	86 (590/685)
Polio drops (last 12 m)	99 (760/767)	99 (502/506)	100 (638/639)	100 (681/682)

Table 3 - Measles vaccination in the four districts among children aged 12-23 months, by sex of child and residence.

	Percent (numbers) who received the vaccination			
Vaccination	Khairpur	Haripur	Khanewal	Sialkot
Measles – all	50 (356/737)	80 (396/497)	65 (413/635)	86 (590/685)
boys	53 (187/370)	82 (215/265)	66 (228/346)	87 (304/348)
girls	48 (159/350)	79 (181/232)	64 (185/289)	85 (286/337)
urban communities	68 (137/200)	96 (46/48)	70 (82/111)	95 (157/166)
rural communities	42 (219/537)	79 (350/449)	64 (331/524)	83 (433/519)

Knowledge and attitudes about vaccinations and role of lady health workers

Table 4 shows the knowledge and attitudes of mothers about vaccinations. Nearly all mothers had heard about vaccinations. Between 76% and 88% of mothers could correctly identify at least one vaccine-preventable illness, in response to an open-ended question. Almost all the mothers believed that it was worthwhile to vaccinate children. Virtually all the mothers in all districts who believed it was worthwhile to vaccinate children gave as their reason (in response to an open-ended question) that it protected the children against illness. Among the few who did not think it worthwhile to vaccinate children, the main reasons (common to all four districts) were that it was "not necessary" or that it "made the child sick" afterwards. Between 83% and 91% of mothers reported they had discussed childhood vaccination within the family. Very few mothers said they had heard of any bad effects of childhood vaccination; rather more in Khairpur than in the other three districts. Among those few mothers who had heard of any bad effects, many mentioned actual side effects of vaccination such as fever and pain and swelling at the site (Khairpur 69%, Haripur 25%, Khanewal 37%, Sialkot 40%), while others mentioned fears and misconceptions about side effects, such as that the child could get polio or die, or that vaccination would make the child sterile.

Less than two thirds of mothers had received a visit by a LHW (Table 3). And among those women who had been visited by a LHW, only about a quarter reported that the LHW had given them any information about childhood vaccination. Thus, only a small proportion (11% to 18%) of all women respondents had been visited by a LHW and told by her about vaccinations.

On the other hand, nearly all the LHWs we interviewed (42/46 in Khairpur; 38/40 in Haripur; 24/29 in Khanewal; and 38/41 in Sialkot) reported they told mothers they visited about the importance and benefits of childhood immunisations. Virtually all the LHWs could mention correctly at least one illness preventable by immunisation; fewer of them said they had heard about side effects of vaccination (28/44 in Khairpur, 18/40 in Haripur, 11/29 in Khanewal, and 11/41 in Sialkot).

Factors related to measles vaccination

The final models from the logistic regression analyses are shown in Table 5. The models differed between districts but had many variables in common. In general, fewer variables remained in the final models from the urban sites than in the models from the rural sites.

Access to vaccination services

In rural sites in Khairpur and Haripur, the presence within 5 km of a government health facility offering vaccination approximately doubled the likelihood that the child had received measles vaccine. In all districts except Sialkot, in rural sites a vaccination team visiting the community also increased the likelihood that the child had received measles vaccine; this effect was much stronger in rural Khanewal. Access was much less important in urban sites. Data were too sparse to allow separate analysis of urban sites in Haripur. In the other three

Table 4 - Knowledge and attitudes about childhood immunisations among mothers.

Knowledge/attitude	Percent (numbers) of mothers			
	Khairpur	Haripur	Khanewal	Sialkot
Have heard about childhood immunisations	83 (2760/3400)	94 (1950/2083)	94 (2323/2490)	98 (2365/2408)
Know correctly at least one vaccine preventable illness	76 (2503/3357)	83 (1717/2079)	76 (1855/2459)	88 (2097/2392)
Believe it is worthwhile to immunise children	91 (3047/3374)	97(2007/2087)	96(2387/2495)	99 (2373/2410)
Have heard of bad effects of immunisation	11 (359/3333)	4 (74/2074)	3 (81/2490)	3 (71/2393)
Have discussed immunisation in the family	83 (2733/3334)	91(1874/2067)	84(2064/2485)	89(2102/2371)
Ever visited by LHW	45(1464/3415)	62(1256/2083)	60 (1447/2496)	65 (1541/2411)
Told by LHW about childhood immunisations:				
among those visited	25 (350/1427)	30 (364/1228)	25 (326/1403)	24 (348/1535)
among all mothers	11 (350/3378)	18 (364/2055)	15 (326/2452)	15 (348/2405)

The slightly different denominators for the different variables reflect the different numbers of mothers who responded to the specific questions.

districts, all the urban communities were within 5 km of a government health facility offering vaccination. In urban sites, a visiting vaccination team did not affect the likelihood of a child receiving measles vaccine.

Household vulnerability

In rural sites, except in Sialkot, a child from a less vulnerable household (that is, a household with a better socio-economic status) was more likely to have received measles vaccine. But in urban sites, household vulnerability was only a significant factor in Khairpur district.

Mother's education and knowledge

In all districts, in both urban and rural sites, a child of a mother with some formal education was more likely to have received measles vaccine, except in urban sites in Sialkot. In Khanewal, the strength of the association between mother's education and measles vaccination was greater in urban sites (adjusted OR 4.27) than in rural sites (adjusted OR 1.79). In Khairpur the effect was similar in urban sites (adjusted OR 2.02) and rural sites (adjusted OR 2.00).

Everywhere, except in urban sites in Khanewal and Sialkot, children of mothers who could correctly identify a vaccine preventable illness were more likely to have received measles vaccine. On the other hand, in Haripur, Khanewal and Sialkot, children whose mothers did not know of any bad effects of vaccination were more likely to have received measles vaccine. The situation was apparently different in Khairpur, where in urban sites knowing of bad effects was not a significant variable in the final model, while in rural sites, children of mothers who had not heard of any bad effects of vaccination were significantly *less* likely to have received measles vaccine.

In addition to factors of maternal education and knowledge, in rural sites children whose mothers reported being visited by an LHW *and* being told by her about vaccinations were more likely to have received measles vaccine.

Discussing and making decisions about vaccination

Children whose mothers reported discussing vaccination within the family were more likely to have received measles vaccine, and this was a strong effect in many places, especially in Khairpur, where it had the strongest individual effect on the likelihood of measles vaccination of any of the variables. Only in Sialkot, once other variables were taken into account, was discussing vaccination within the family not significantly related to the likelihood of a child receiving measles vaccine.

The mother's participation in the decision about vaccinating the child was significantly related to the likelihood of the child receiving measles vaccine only in Haripur (rural sites) and in urban sites in Sialkot.

Sex of the child

While measles vaccination rates were slightly higher among boys than girls (see Table 3), when other variables were taken into account, boys were more likely to receive measles vaccine only in rural sites in Khairpur.

Parental reasons for not vaccinating children

We asked mothers of children who were not fully vaccinated the main reason for this. The responses of mothers in urban and rural communities are shown in Table 6. Common reasons were to do with either "carelessness" of the mother or family, or problems with access to vaccination (facilities too far away or teams not visiting). In rural sites access problems predominated, while in urban sites more mothers cited parental carelessness or lack of awareness (except in Haripur with very few responses from rural sites).

Views from the focus groups

Presented with the evidence about vaccination rates in the district, the separate male and female group participants gave their views about why children are not vaccinated and suggestions for what they believed could improve vaccination rates. The discussions provided qualitative

Table 5 - Final logistic regression models of variables associated with measles vaccination among children aged 10-59 months.

Explanatory variables	Adjusted Odds Ratio (OR)	Cluster-adjusted 95% confidence interval of adjusted OR
Urban sites in Khairpur district		
Mother has some formal education	2.02	1.01–4.05
Household not vulnerable	1.55	1.07–2.24
Mother can correctly identify a vaccine preventable illness	2.47	1.04–5.83
Mother has discussed immunisation in the family	4.17	2.55–6.83
Rural sites in Khairpur district		
Mother has some formal education	2.00	1.39–2.87
Household not vulnerable	1.73	1.47–2.04
Male child	1.40	1.18–1.64
Mother can correctly identify a vaccine preventable illness	2.44	2.10–2.84
Mother visited by LHW and told about vaccination	3.11	1.82–5.32
Mother has not heard of any bad effects of vaccination	0.44	0.33–0.57
Mother has discussed immunisation in the family	4.05	1.89–8.66
Government health facility offering vaccination within 5 km	2.02	1.45–2.81
Vaccination team visits the community	1.25	1.16–1.36
Rural sites in Haripur district		
Mother has some formal education	1.59	1.11–2.27
Household not vulnerable	1.46	1.16–1.85
Mother can correctly identify a vaccine preventable illness	1.81	1.59–2.06
Mother visited by LHW and told about vaccination	1.60	1.14–2.23
Mother has not heard of any bad effects of vaccination	3.05	1.85–5.01
Mother has discussed immunisation in the family	2.54	1.78–3.61
Mother participates in decision about vaccinating the child	1.57	1.21–2.04
Government health facility offering vaccination within 5 km	1.84	1.37–2.48
Vaccination team visits the community	1.48	1.31–1.67
Urban sites in Khanewal district		
Mother has some formal education	4.27	1.41–12.90
Mother has not heard of any bad effects of vaccination	7.75	1.43–41.89
Mother has discussed immunisation in the family	3.36	2.00–5.66
Rural sites in Khanewal district		
Mother has some formal education	1.79	1.26–2.53
Household not vulnerable	1.77	1.36–2.30
Mother can correctly identify a vaccine preventable illness	2.18	1.99–2.38
Mother visited by LHW and told about vaccination	1.47	1.01–2.14
Mother has not heard of any bad effects of vaccination	2.19	1.27–3.77
Mother has discussed immunisation in the family	3.65	2.68–4.99
Vaccination team visits the community	5.63	5.49–5.77
Urban sites in Sialkot district		
Mother participates in decision about vaccinating the child	2.84	1.20–6.74
Rural sites in Sialkot district		
Mother has some formal education	1.77	1.15–2.72
Mother can correctly identify a vaccine preventable illness	1.77	1.01–3.09
Mother visited by LHW and told about vaccination	1.80	1.01–3.22
Mother has not heard of any bad effects of vaccination	3.27	1.08–9.92

Data for urban sites in Haripur were too sparse to allow separate analysis.
All urban sites in Khairpur, Khanewal, and Sialkot were within 5 km of a government health facility offering vaccination.
The explanatory variables included in all the initial models were: mother has some formal education; household not vulnerable; mother can correctly identify a vaccine preventable illness; mother visited by LHW and told about vaccination; mother has not heard of any bad effects of vaccination; mother has discussed immunisation in the family; mother participates in decision about vaccinating the child; government health facility offering immunisation within 5 km; vaccination team visits the community.

Table 6 - Reasons given by mothers of children not vaccinated or not fully vaccinated (among those who gave a reason)[a].

	Weighted percent (number)							
	Khairpur		Haripur		Khanewal		Sialkot	
Main reason why child not vaccinated / not fully vaccinated	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
"Carelessness" on part of mother or other family members	19 (56)	7 (143)	15 (2)	27 (126)	17 (27)	9 (95)	51 (29)	36 (125)
Lack of time / no one to take child for vaccinations	8 (23)	5 (98)	8 (1)	10 (45)	9 (11)	7 (74)	12 (7)	12 (37)
Vaccination would harm the child	16 (42)	3 (54)	15 (2)	11 (50)	12 (17)	8 (85)	14 (8)	13 (43)
Lack of awareness about vaccinations or vaccines schedule	8 (21)	4 (81)	31 (4)	11 (55)	11 (14)	11 (110)	4 (2)	6 (20)
Access problems / no nearby facility / no visit of team	33 (95)	68 (1412)		18 (95)	35 (59)	56 (622)	9 (5)	22 (73)
Don't believe in vaccination / it's useless / not our tradition	11 (33)	5 (99)	31 (4)	12 (61)	15 (19)	7 (78)	8 (5)	5 (16)
Family members do not allow child to be vaccinated	2 (7)	1 (23)		9 (38)	1 (2)	1 (8)	2 (1)	4 (12)
Cannot afford vaccination / too poor to vaccinate	2 (6)	8 (167)		2 (11)		2 (16)		2 (8)
Total	*100 (283)*	*100 (2077)*	*100 (13)*	*100 (481)*	*100 (149)*	*100 (1088)*	*100 (57)*	*100 (334)*

[a]This was an open-ended question. We coded the responses given by mothers and subsequently further grouped together similar responses.

information to give context to the quantitative findings from the household survey.

Personal factors

Some group participants expressed the view that some parents do not understand the risks of not vaccinating children.

> "People are not educated. That's why they are not aware about the dangers of lack of vaccinations." *(male group, Khanewal)*

> "Girls are married off at a young age. They don't know anything about these things." *(female group, Sialkot)*

They also suggested that some parents do not want to understand, or that they weighed future risks less heavily than present concerns.

> "Some mothers don't want to understand the risks [of non-vaccination]. They say their child is fine and healthy, he doesn't need anything else." *(female group, Khairpur)*

> "Our problems are so many that we are only able to think about dangers coming now, not those that seem far away." *(male group, Khanewal)*

However, participants in many groups thought parents understood very well why they should have their children vaccinated; they cited other reasons for these parents not having their children vaccinated. Sometimes they blamed parental carelessness, or negative and fatalistic family attitudes about vaccination and illness.

> "People fully understand the risks. But they are careless. They don't bother to take their children for vaccination." *(male group, Khairpur)*

> "My mother-in-law says 'What kind of children have you produced that they ought to be vaccinated? We were never vaccinated, so why are you behaving so delicately?'" *(female group, Khanewal)*

> "Whether a child is vaccinated or not, he is bound to get measles once in his lifetime." *(male group, Haripur)*

Some people pointed to concerns about side-effects of vaccines, lack of efficacy of vaccine, or other negative beliefs about vaccines.

> "People love their children. They avoid getting them vaccinated because the injections are painful for children." *(male group, Sialkot)*

> "Some children have died after getting a vaccine injection. The rest of the mothers around here are now scared." *(female group, Khairpur)*

> "To hell with vaccinations. Children get measles even when they are vaccinated against it." *(female group, Sialkot)*

> "People are afraid that vaccinations will sterilize their children." *(male group, Khanewal)*

Other factors

Many people cited poverty as the reason why parents do not vaccinate their children.

> "People are poor, but they don't want anyone to know about their condition. They cannot afford to take their children for vaccinations, so they don't." *(female group, Khairpur)*

Participant 1:"We are only bothered about earning 100 rupees a day. We don't have time to think about measles vaccinations."

Participant 2: "People have money to go and watch a movie. Why don't they have money when it comes to their child's health?" *(male group, Haripur)*

Many people complained about problems with access to and experience of vaccination services, whether from visiting vaccination teams or health facilities. It was clear that, in general, people relied on vaccination teams visiting their community, rather than expected to take their children to a health facility outside the community. In many parts of Pakistan women have limited mobility outside their homes.

"We are not allowed to go to health facilities. That's why we cannot have our children vaccinated." *(female group, Khairpur)*

"Vaccination teams don't visit our area. How can anyone blame parents and their children?" *(female group, Khanewal)*

"The government promises to provide free vaccinations. But when the teams get here, they charge us 100 rupees for each injection." *(Male group, Haripur)*

"Teams come and write down false names. That's why some children are not vaccinated." *(Male group, Khanewal)*

"When we go to a health centre, they tell us the vaccine is finished." *(female group, Khanewal)*

"Health workers re-use the same syringe, and charge us money for a new one." *(female group, Sialkot)*

Increasing vaccination rates

Mostly, participants called for increased access to free vaccination services, saying that only then can parents be expected to get their children vaccinated.

"Teams must go door to door to vaccinate children. Parents who refuse to have their children vaccinated must be fined." *(female group, Sialkot)*

"Two days before the teams are expected to arrive, it should be announced through the mosque so that mothers can be prepared." *(female group, Khanewal)*

"We will take our children for vaccinations if there is better transport available." *(female group, Khairpur)*

Discussion

In this paper we have used measles vaccination as an indicator of vaccination coverage. Measles vaccination is a single dose in Pakistan, and is the last of the scheduled childhood vaccinations, targeting children nine months old. Typically, coverage with measles vaccination is considerably lower than that with BCG (given at birth), and similar to that of three doses of DPT. Children who do not complete the course of DPT often do not have measles vaccination either.

We used maternal report as our indicator of the vaccination status of children. Some authors from developed countries have suggested that maternal recall is not a good enough indicator of vaccination status compared with health facility records [20,21]. However, a study from Italy found that parental recall alone was similar to other measures of vaccination status and concluded that "verbal recall should be accepted as reasonably reliable in the absence of cards" [22], while in Australia parental recall of measles vaccination coincided as well as vaccination cards with the presence of antibodies [23]. A study in Turkey, taking polio antibodies as the 'gold standard', found that parental recall was more sensitive but less specific than official records [24]. A study in India found that maternal recall underestimated children's vaccination status, but using vaccination cards was not helpful because less than half the mothers had cards and the cards were often incomplete or grossly inaccurate [25]. Our own experience in Pakistan is that vaccination cards are frequently missing or highly inaccurate. Valadez et al. in Costa Rica concluded that maternal recall could be used for estimating vaccination status, especially for younger children and for single dose vaccines [26]. Langsten and Hill in rural Egypt found that mothers reports were later confirmed by card data for at least 83% of children aged 12-23 months [27]. Gareaballah and Loevinsohn found that mothers' reports in the Sudan were accurate and concluded that for both DPT and measles vaccination, reliance on mothers' reports alone gave accurate estimates of vaccination coverage [28]. Goldman and Pebley in Guatemala highlighted the serious problems with service-based data (including vaccination cards) and recommended using mothers' reports to improve estimates of vaccination coverage [29]. Importantly, authors have reported that even if maternal recall may under- or over-estimate vaccination status, this was not related to factors such as maternal education level or poverty status [25,30]. We therefore believe that our reliance on maternal recall of vaccination status is reasonable and is not likely to have introduced bias into the analysis of factors related to vaccination in the four districts.

The four districts included in this study had measles vaccination coverage rates ranging from 50% up to 86%, in

the context of a reported national measles vaccination rate of 60% in 2006-07 [2]. National surveys have reported considerable variation across Pakistan in coverage with measles vaccination and other vaccinations [2,31]. For example, the 2006-07 Demographic and Health Survey reported measles vaccination rates of 51% in Sindh, 54% in Balochistan, 57% in NWFP, and 65% in Punjab [2]. Even these provincial figures mask considerable variation. Our focus districts have relatively good rates for their provinces; Khairpur has about the average rate for Sindh, Haripur is well above the NWFP average, Khanewal is at the Punjab average, and Sialkot is above the Punjab average. Even average district figures do not tell the whole story; in Khairpur there was as much as 26% difference in measles vaccination coverage between urban and rural communities, while the national urban-rural difference is reported to be about 10% [2]. A survey of immunisation coverage in a district of India also found big differences between *panchayats*, with higher coverage in urban and peri-urban *panchayats* [32].

Despite the important differences in overall measles vaccination rates between the four districts, we found common factors associated with measles vaccination. Mother's education was related to measles vaccination in all four districts, in urban and rural sites. Many authors have noted mother's education as an important determinant of childhood vaccination in developing countries [6,9,33,34]. The big difference in the proportion of mothers with any formal education between Khairpur and Sialkot may go some way towards explaining their very different vaccination rates.

The poor are less likely to access health care [3] and less likely to be covered by vaccination programmes [35]. Overall increases in measles vaccination in developing countries in the 1990s have often been accompanied by an increase in the gap between the rich and poor [36]. In a study in Bangladesh, higher socio-economic status was associated with childhood vaccination [33]. We found that children from less vulnerable households (our indicator of better socioeconomic status) were more likely to be vaccinated. In Sialkot, the richest district among the four, and in urban sites in Khanewal, we did not find that household vulnerability was associated with vaccination, once other variables were taken into account. This might indicate that when the overall level of services is better and access to services is easier, socio-economic status becomes less of a barrier to vaccination. Discussions in our focus groups confirmed the importance of poverty as a barrier to vaccination in many cases, as parents described being unable to afford the costs of the supposedly "free" immunisations: travel costs, opportunity costs, and demands for unofficial payments. A study of a measles epidemic in Mexico described the out of pocket costs associated with vaccination and also the way the poorest households bore disproportionately the costs of not vaccinating [37].

Some authors have documented a greater likelihood of vaccination among male children [6,33,35]. However, we found that when other variables were taken into account, the sex of the child was associated with vaccination only in rural areas of Khairpur.

Maternal knowledge about vaccine preventable illnesses was quite strongly associated with vaccination in virtually all locations in our study. But knowledge of benefits is not enough by itself to ensure vaccination. Some focus group participants suggested that lack of knowledge of the benefits of vaccination or the risks of non-vaccination were reasons why children were not vaccinated, as has been reported from elsewhere [38], but many others felt failure to vaccinate children happened despite parents being aware of the benefits. Fear of adverse effects of vaccination is cited as a reason for children not being vaccinated, in both qualitative and quantitative studies [9,39] and we found that children of mothers who did not report having heard of bad effects of vaccines were more likely to be vaccinated, in most places. However, this variable had the opposite effect in rural areas of Khairpur; perhaps in this area where very few women have any formal education, having heard of any bad effects equates with being more knowledgeable overall about vaccinations. In urban Khanewal, on the other hand, there was a strong negative effect of having heard about bad effects of vaccines; perhaps here there have been strongly negative stories about vaccination incidents that have discouraged some parents from vaccinating their children.

We have proposed an expansion of the standard knowledge, attitudes, practice (KAP) approach to behaviour change, known as CASCADA [40]. This partial order of causality includes a number of intermediate steps between conscious knowledge and action, the step immediately preceding action being "discussion". In three of the four districts, the mother discussing vaccination in the family was the variable most strongly associated with the child being vaccinated against measles.

While these "demand-side" factors are important in determining vaccination rates, "supply-side" factors are also relevant. Fewer variables remain in the final models from urban sites in the four districts, compared with rural sites. In particular, variables indicating access to services are prominent determinants of vaccination in rural sites: whether there is a government facility providing vaccinations within 5 km of the community and whether a vaccination team visits the community. Qualitative studies have reported that parents cite problems with services

as the main obstacles to having their children vaccinated [11,39,41,42]. In this study, groups of both male and female parents mentioned a number of problems with the provision of vaccination services that made it difficult for them to have their children vaccinated.

A positive supply-side factor was visits from LHWs. This positive effect was apparent in rural areas in all four districts. A study of vaccination rates in Bangladesh also found that children living in areas visited by family welfare assistants were more likely to be vaccinated [33] and in Thailand children in families who had contact with village health volunteers were more likely to be vaccinated [10]. A systematic review of lay health workers found a significant benefit of lay health worker interventions to promote vaccination uptake in both children and adults [43].

The pattern of factors affecting vaccination uptake has been reported to differ between countries [44]. Our findings show how it can differ between and even within districts. For district governments planning interventions to increase vaccination services equitably, these local differences matter. For example, in Khanewal dealing with negative perceptions about vaccine side-effects would be important. In Khairpur, extending programmes to reach and inform uneducated women could have an important role. These activities would be in addition to efforts to improve service access, for example through visiting vaccination teams. Further analysis can indicate the effects of combinations of variables [45] and the potential benefits, in terms of gains in numbers of children vaccinated, of different interventions and combinations of interventions [17]. This information about potential gains, together with information about costs of different interventions can assist district planners to make rational decisions about funding priorities.

Conclusions

There are large variations in childhood vaccination rates between districts and even within districts in Pakistan. While many of the variables associated with vaccination are common across different localities, their relative importance varies. Access to services is a more important factor in rural areas. Parents report difficulties with services as important reasons for not vaccinating children. The pattern of variables related to vaccination varies between and within districts; effective and equitable planning of vaccination services will differ between districts, based on evidence of this sort. It would be of interest to see if similar analyses of factors related to vaccination coverage in other countries reveal the same degree of local heterogeneity.

List of abbreviations used

CIET – Community Information for Empowerment and Transparency; LHW – Lady health worker; NWFP – North West Frontier Province.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

AC designed the survey, undertook the analysis and drafted the report; NA reviewed the design, supported the analysis and reviewed the report; KO was responsible for the survey in Khairpur and for data management, supported all the district surveys, and reviewed the report; NMA helped manage the surveys in all districts and reviewed the report; AK was responsible for the survey in Haripur and reviewed the report; UUC was responsible for the surveys in Khanewal and Sialkot and reviewed the report; and UA assisted with the surveys, especially the focus groups, was responsible for extracting from the focus group reports, and reviewed the report.

Acknowledgements

This work was carried out with the aid of a grant from the International Development Research Centre (IDRC), Ottawa, Canada, as part of the Canadian International Immunization Initiative Phase 2 (CIII2). This initiative is a project of the Global Health Research Initiative (GHRI). The views expressed are those of the authors and do not necessarily reflect the views of IDRC, CIDA or the Canadian Government.

We thank the nazims and governments of Khairpur, Haripur, Khanewal, and Sialkot for their active support of this work. We are grateful to Sohail Saeed and Amar Dass for their support with data management, and to the CIET coordinators and field teams who undertook the surveys in each district. We thank in particular the citizens of these four districts who took the time to respond to the household survey and share their views in focus group discussions.

This article is published as part of *BMC International Health and Human Rights* Volume 9 Supplement 1, 2009: The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants. The full contents of the supplement are available online at http://www.biomedcentral.com/1472-698X/9?issue=S1.

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BMC International Health and Human Rights

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Systematic review

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Increasing the demand for childhood vaccination in developing countries: a systematic review

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from The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants

Published: 14 October 2009

BMC International Health and Human Rights 2009, **9**(Suppl 1):S5 doi:10.1186/1472-698X-9-S1-S5

This article is available from: http://www.biomedcentral.com/1472-698X/9/S1/S5

Abstract

Background: Attempts to maintain or increase vaccination coverage almost all focus on supply side interventions: improving availability and delivery of vaccines. The effectiveness and cost-effectiveness of efforts to increase demand is uncertain.

Methods: We performed a systematic review of studies that provided quantitative estimates of the impact of demand side interventions on uptake of routine childhood vaccination. We retrieved studies published up to Sept 2008.

Results: The initial search retrieved 468 potentially eligible studies, including four systematic reviews and eight original studies of the impact of interventions to increase demand for vaccination. We identified only two randomised controlled trials. Interventions with an impact on vaccination uptake included knowledge translation (KT) (mass media, village resource rooms and community discussions) and non-KT initiatives (incentives, economic empowerment, household visits by extension workers). Most claimed to increase vaccine coverage by 20 to 30%. Estimates of the cost per vaccinated child varied considerably with several in the range of $10-20 per vaccinated child.

Conclusions: Most studies reviewed here represented a low level of evidence. Mass media campaigns may be effective, but the impact depends on access to media and may be costly if run at a local level. The persistence of positive effects has not been investigated. The economics of demand side interventions have not been adequately assessed, but available data suggest that some may be very cost-effective.

Background

Routine childhood vaccination is an important prevention strategy with largely proven impact. The WHO claimed that, in 2001, childhood vaccination prevented 61% of deaths from measles, 69% of tetanus deaths, 78% of pertussis deaths, 94% of diphtheria deaths and 98% of polio deaths [1].

Despite this impressive potential, childhood vaccination coverage is stagnating or even deteriorating in some areas in South Asia and large parts of Africa [2]. Responses to the deteriorating coverage have focussed almost entirely on supply side improvements, including the development of new vaccines and extension of existing delivery services [3,4]. Much less is known about what increases *demand* for vaccination and the uptake from the users' perspective. A recent systematic review of 60 studies of evidence on improving routine vaccination programs in developing countries found only three studies that increased demand for vaccination [5].

In preparation for a cluster randomised trial of knowledge translation (KT) in the Balochistan province in Pakistan [6], we reviewed the literature on efforts to stimulate demand for routine childhood vaccination. The trial aimed to increase the demand for vaccination without relying on improvements or extension of the health services offered by the government.

Methods

We developed an *a priori* protocol. Initial literature scans identified published systematic reviews of the childhood vaccination literature. Two reviewers (BS, DH) scrutinized these to identify relevant studies, and these were included in the review. We then searched for primary studies published since 2004 (the most recent literature update from existing reviews) using MEDLINE, POPLINE, ECONLIT, EMBASE, CINAHL and the Cochrane Library. We did citation searches on relevant articles using SCOPUS up to the end of September 2008. Search terms varied by database (details are available from the authors) and included vaccin*, immuni*, econom*, cost*, benefit* 'developing countries' and the names of countries that are categorised as 'low income' by the World Bank. We did not limit the searches by study type. These searches yielded 71,796 citations between 2004 and 2008.

Combinations of search terms identified a smaller number of potentially relevant titles from each database: MEDLINE (335), EMBASE (106), and CINAHL (27). There was considerable overlap between the retrieval lists for these databases. Two readers (BS, DH) examined all titles and identified 12 articles describing community-based interventions that might increase the demand for childhood vaccination (see Figure 1).

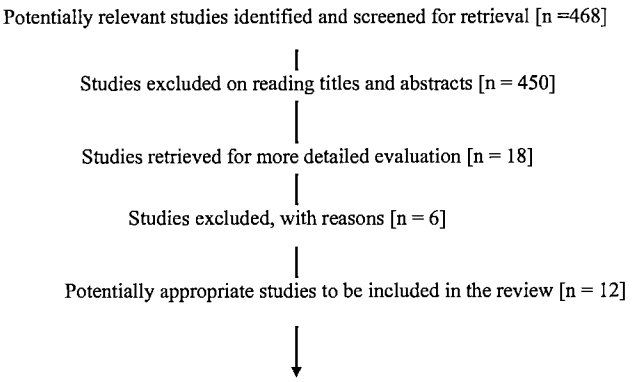

Figure 1 - Flow Chart for included and excluded systemic reviews and primary studies.

We excluded studies of exclusively supply side initiatives and those from developed countries. We included evaluation of national vaccination campaigns and the impact of community health workers when reports included a description of activities that seemed designed to increase demand for childhood vaccination. We evaluated studies on media campaigns, focus groups and microfinance programs and incentives. We also included studies containing cost data, and those from developing countries. Two authors (BS, DH) read the full text copies of reports of these studies.

Where interventions described a clear communication strategy we attempted to categorise it as 'knowledge transfer' – a unidirectional process where research is conceptualized and conducted, and the results are then made available to the end-users – or 'knowledge translation', a process that involves active and conscious participation of knowledge translators and knowledge recipients – in this case the parents of children. We confined our literature retrieval to studies that provided quantitative estimates of the impact of 'demand side' interventions. If they used mixed methods, including qualitative techniques, they were included; but we did not extract or evaluate qualitative data. We sought studies with the highest levels of methodological rigour, following an evidence based approach [7]. In the case of published systematic reviews and meta-analyses we assessed methodological quality using the AMSTAR, a validated instrument [8,9]. We conducted formal assessment of randomised trials using the SIGN 50 instrument [10]. However, the broad range of the other study types required an informal approach to quality assessment and precluded any attempt at data pooling (meta-analysis).

Results

Review of reviews

Our search identified seven potentially relevant systematic reviews [3,5,11-15] and colleagues reviewed evidence

Table 1 - Characteristics of systematic reviews included in this study.

Review	Literature search and eligibility criteria	Characteristics of studies	Population	Outcome
Pegurri et al 2004 [3]	To Dec 2001/published and grey literature Adequate description of the intervention and either time series or 2 population groups	Evaluated Cost or Cost Effectiveness	Children <5y in developing countries	% increase in coverage
Batt 2004 [13]	Search up to May 2003 Extensive grey literature including interviews with 28 international experts searching large databases, and a comprehensive search and retrieval of information from a large number of organizations e.g. WHO, GAVI, UNICEF	Evaluated Cost, Effectiveness and Cost Effectiveness	Children <5y in developing countries	% increase in vaccine coverage, cost and dollar cost per fully vaccinated child
Haines 2007 [14]	Existing published RCTs, Cochrane library, Grey literature sources, references	Evaluated impact and cost effectiveness of Community health workers undertaking a range of tasks relevant to child survival goals	Children <5 in developing countries	% increase in coverage
Ryman 2008 [5]	Search up to Dec 2004 Extensive search in public and grey literature and they contacted 31 experts in the field	Effectiveness only	Routine vaccination in low and middle income countries	Change and FVC in children

*Items from the AMSTAR instrument are described in Additional file 1: A measurement tool to assess systematic reviews (AMSTAR).

on a broad range of perinatal and neonatal interventions, including tetanus toxoid to prevent neonatal or maternal tetanus. They did not consider childhood vaccinations. Edejer and colleagues reviewed the cost-effectiveness of several interventions in children under the age of five [12]. The interventions included measles vaccination, but not interventions to increase the uptake of vaccines. The Cochrane Review of the impact of lay health workers [12] included three randomised trials of interventions to increase vaccine coverage. These were conducted in developed countries and one was concerned with adult vaccination practices. All were excluded from this review.

Table 1 summarises the other four systematic reviews, all of which are relevant to childhood vaccination. Pegurri and colleagues [3] reviewed published studies up to 2001. They examined supply side interventions (bringing services closer to the community), demand side interventions (door to door canvassing) and interventions that had features of both supply and demand (mass vaccination campaigns). The increase in full vaccine coverage rose from the baseline 34% by an average of 27%.

Most studies showed improvement and the authors found no difference in effectiveness between 'supply side', 'demand side' and 'mixed' strategies. The economic analyses found estimates of costs per fully vaccinated child ranging from $0.9 with peer training in Indonesia to $245 for children under one year of age in an outreach program in Mauritania. Most estimates fell between $10 and $20 per fully vaccinated child. Channelling (door to door canvassing) and community health workers were both cost effective and both involved some degree of community interaction. The studies provided little information on duration of the improvement of community uptake of vaccinations. The review also highlighted the generally poor methods employed in the evaluation of these key public health interventions.

The review by Batt and colleagues [14] (Table 1) came from the same institution as that of Pegurri et al and used similar methods [3]. The added value was an extraordinarily detailed search and retrieval of the grey literature. This included searches of institutional document centres (WHO and UNICEF) and interviews with experts from key institutions around the world. The review identified 24 relevant intervention studies, 15 at national level. The 'demand-side' interventions involved education of communities and improving awareness of 'missed opportunities'. Studies of mass media, health worker education and community education claimed large effect sizes – absolute increases in proportions of full vaccine coverage (FVC) of up to 50%. The average effect of all interventions was to increase FVC from 44% to 64%, an increment similar to that estimated by Pergurri [3]. Most of the estimates of cost-effectiveness ratios fell below $50 per additional fully vaccinated child. There was no clear indication of whether any particular approaches to extending vaccine coverage were self-sustaining and led to long-term improvements.

Haines and colleagues [15] highlight the role of community health workers (CHW) in low income countries in undertaking interventions designed to improve child survival, including vaccination. CHW can be given practical training in delivery of key services and are cheaper to train and employ than doctors and nurses. The authors discuss arguments around CWHs as extensions of the health care system and their advocacy roles as agents for changing community behaviours. Some of this activity can be viewed as demand-inducing, although separating this from the supply side is difficult. The review considered a range of preventive and curative interventions that can involve CHWs, presenting results as a narrative. They point to the advantages of integrating vaccination programs with other interventions (distribution of impregnated bed nets for malaria and Vitamin A supplementation).

The recent review by Ryman [5] concentrated on efforts to strengthen routine vaccination services and used a broader search approach than did Pegurri [3] and Batt [14]. They retrieved papers published up to the end of 2004, including an extensive review of the grey literature. They excluded most of these candidate studies, however, because of methodological inadequacies. Their approach to study eligibility required a score over 60% on ratings of methodological quality. Quality criteria were explicit, but the threshold of 60%, measured by an un-validated instrument, adds an unspecified dimension. Only 25 papers met their criteria for inclusion and three studied KT to increase demand for vaccination. These are included in our review of individual studies (Table 2). Ryman [5] and colleagues comment that "mass communication campaigns have the potential to reach large numbers of people if access to the type of media... is good." Participation in an NGO credit (micro-finance) program increased vaccination coverage without the provision of additional services [5]. Training community members to provide information regarding vaccination and providing resource rooms did not increase overall vaccination coverage but improved the timeliness of vaccination.

The quality of the four systematic reviews included in our review was mixed. All four performed comprehensive literature searches. Three reviews included grey literature. The authors provided reasons and justification for low scores, on several items of AMSTAR [8,9]. None of the included reviews had published *a priori* protocols nor had two reviewers check the selection and data extraction. No reviewer provided the list of included and excluded studies.

Only one review provided the characteristics of the included studies. Although the majority of reviewers assessed the scientific quality of the included primary studies, none of the reviewers included these measures of quality in their conclusions and recommendations. The majority of authors did not conduct a meta-analysis, largely because of the limitations of the primary studies in terms of consistent application of methodological and reporting standards. None of the reviewers addressed the potential competing interests of authors of the primary studies (Table 1).

In light of the broadly consistent findings of these published reviews, we extracted individual studies from them that reported the use of any information communication strategy to increase community demand for routine childhood vaccination. These reviews were extremely comprehensive in their coverage and covered the period up to the end of 2004. We augmented these with new studies published between January 1st 2004 and Dec 31st 2007.

Review of individual studies

From the literature search and scrutiny of the published systematic reviews we identified eight studies [6,16-22] that examined demand side initiatives to increase routine childhood vaccine coverage (Table 2). The studies can be categorised as those that involve KT and those that involve other approaches, including incentives.

Knowledge translation interventions

Two studies considered the effect of mass media on uptake of vaccination. Zimicki and colleagues [16] described a national measles vaccination intervention in the Philippines that emphasized logistical information in the media (where and when vaccination was available), identifying a special day of the week as 'vaccination day'. The campaign consisted of four television and radio advertisements emphasizing the dangers of measles and the availability of free vaccination; newspaper inserts identified weekly vaccination days. Two surveys (before and five months after the media campaign) measured the impact of the campaign among mothers and carers of children under two years of age. The study included interviews with staff at 60 health centres and observations of 10 children who attended the health centres on vaccination days. The proportion of fully vaccinated children increased from 54% to 65% and the proportion of children aged 9-11 months who completed all vaccinations increased from 32 to 56%. There was improved knowledge about vaccination and some participants who recalled the campaign attributed some of their increased knowledge to this. Increased knowledge was associated with higher rates of completed vaccination. The interviews and observations at clinics revealed no changes in practices, so the authors attributed the increased uptake and completion of childhood vaccination to the mass media campaign. They argued that this was more likely in the targeted urban areas, with good access to radio television and newspapers. As with many countries where

Table 2 - Characteristics of included studies.

Study ID	Participants	Study interventions	1) Evaluation Methods 2) Study quality	Study outcomes	Results
Loevinsohn 1987 [19]	Santa Rosa del Penon in the pacific northwest of Nicaragua	Mass vaccination campaigns; stationary clinics and mobile clinics with or without food supplementation as an incentive.	1) Measurement of attendance rates at mobile and stationary well child clinics. 2) Repeated surveys of clinic attendance; little detail of data collection or quality control; study used attendance rather than vaccination status as the outcome; lack of contemporaneous control group makes order effects possible.	Attendance at clinics; personnel time.	Regular mobile N=425, 63.3% Mass vaccination campaigns N= 889, 77,1% Stationary with food N=764, 94.1% Mobile with food N=547, 99.2% Stationary clinics took up half as much healthy worker time as mobile clinics Person hours per village served MVC 8.5; Mobile clinics 38; Stationary clinics 19. Attendance declined in a linear fashion with distance from stationary clinics.
Cutts 1990 [20]	Mothers from Mozambique Maputo 210 children aged 12-23 months	Comprehensive and integrated intervention: Outreach teams visited in 3 consecutive monthly 'pulses'; communications system to inform villages about arrival of mobile teams. Training of representatives from grass roots organisations (ten-family leaders); development of community-based volunteers from grass roots organizations; Door-to-door canvassing. Health departments and Executive Councils formed intersect oral communities to organize activities with emphasis on mobilization	1) Cumulative BCG vaccination rates in the pulse project districts in 1984 (pre) and 1987 (post). 2) Difficult to apply rigorous study methods in a war zone; Post survey used EPI cluster sampling method; vaccination rates obtained from health cards; lack of contemporaneous control group makes order effects possible.	Comparison of coverage before and after program acceleration.	Measles vaccination 1985-1987 Beira (1% increase) Inhambane (13% increase) Tete (22% increase) Quelimane (31% increase).
Zimicki 1994 [16]	Philippines Pilot in Manila (1988) and nationally (1990) Mothers or permanent carers with children under 2 years	The mass-media element of the campaign was March–Sept 1990. It focussed on measles as a way of bringing mothers to health centres, mainly in urban areas. Four television and four radio advertisements were broadcast, and advertisements were printed in newspapers reminding people of vaccination day. Concentrated on the dangers of measles Other promotional materials included posters and bunting.	1) Two surveys of the carers of children aged < 2 years to measure a change in knowledge) and vaccination rates. A pre-post study of 60 health centres in the same areas. 2) National campaign, so parallel control group not possible; used a rigorous multi-stage cluster sampling with weighted analysis adjusted for clustering to standardise the 1990 sample to 1989 sample; lack of contemporaneous control group makes order effects possible.	12-23 month vaccine coverage (all 8 vaccines). 2-8 month vaccine coverage (at least 4 vaccines). Vaccination started on time and finished on time.	Mean number of vaccinations: Rate difference 53.6% (1989) to 64.5% (1990) (RD 10.9 (2.8-19.0) -starting on time (12.3 (1.5-23.1) -finished on time (24.0 (12.2-35.8) -appropriate early (8.5 (0-17.1) Exposure to the mass-media campaign and knowledge level RD2.32 (2.19-2.46) Increase knowledge increase vaccination (1989-1990) Absolute diff 0.77 (P<0.0001).

(Continued on the next page)

Table 2 - Characteristics of included studies *(Continued)*.

Study ID	Participants	Study interventions	1) Evaluation Methods 2) Study quality	Study outcomes	Results
Brugha 1996 [22]	Three towns in Eastern region of Ghana	Program of home visits during which parents or carers were advised to take the children to the next under five's clinic of their choice, and were given a referral note for the clinic. The intervention targeted parents of unvaccinated children. Up to 3 additional visits by a nurse over the next 6 months if the child did not complete vaccination.	1)Cluster randomised trial was conducted in the largest of the three towns. 2) Quality rating in Table 3.	Completed vaccination rates before and after the intervention using Road to Health cards, clinic records supplemented by maternal history.	Vaccination coverage rose from 59.5% to 86% in the intervention group compared with 60.7% to 66.7% in the control group. The difference in the increases in the intervention and control groups was statistically significant (P<0.005). Vaccine coverage also rose in the other two towns that were also subject to the intervention but did not participate in the randomised trial.
Tulchinsky 1997 [21]	Communities in Hebron, the West Bank. 69 villages in Hebron and 20 in other areas	Village Health Rooms (VHR) implemented by village leaders. Each village health room is staffed by a female village guide selected by the village leaders and health office. The guide arranges mothers' visits. They also organize national vaccination days and have a teaching as well as a service role.	1) Data from individual patient records; household surveys to determine community basic demographic information and immunisation status. 2) Data collection based on secure records but lack of contemporaneous control group makes order effects possible.	Coverage utilization and improved health status; costs and program longevity	Coverage compared VHR with baseline data from the village household survey. 90% of children up to the age of 2 years had received measles or MMR and 96% had 3 or 4 doses of DPT. There was little changed from previous estimates but in the past children generally had vaccination delayed into the third year of life.
Amin 1997 [18]	Villages from 5 NGO regions in Bangladesh. 3,564 married women under the age of 50	NGO provision of small collateral-free area focused credit.	1) Cross sectional survey Multistage cluster sampling strategy; recruitment from villages where NGOs maintained rural credit programs and control areas where NGOs had no presence. 2) Parallel study of intervention and control areas; able to study credit recipients and non-recipients in program areas. Multivariate analyses to adjust for potential confounders.	Vaccination status amongst loanees and non-loanees from credit and non-credit areas	Mean age 29, av 3.1 children per household Last born vaccinated Total area 62.4 % Credit program 67.8% non-member 58.8% Comparison area 49.4 % Last born less than one Total area 66.7% Credit area 71.8% non-member 63.3% Comparison area 50.7% Infant mortality rates were lower in members of credit schemes in program areas.

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Table 2 - Characteristics of included studies *(Continued)*.

Study ID	Participants	Study interventions	1) Evaluation Methods 2) Study quality	Study outcomes	Results
Hutchinson 2006 [17]	People living in rural areas of Bangladesh	'Smiling Sun' communication program included a variety of important health-related messages. The delivery media included signboards, television drama series, television advertisements, radio spots, press ads in newspapers and local publicity. Messages related to maternal and child health, family planning and communicable disease control (incl vaccination).	1) Cross sectional survey using two-stage cluster sampling; correlation between exposure to the campaign and reported vaccination status was calculated. Extensive costing data collected. 2) National campaign, so parallel control group not possible. Used bivariate probit likelihood method to estimate program effectiveness.	Self-reported exposure to the 'Shining Sun' media campaigns and simultaneous self-reporting of key health-related behaviours (use of ante-natal care and use of childhood vaccinations). Cost-effectiveness analyses.	Mothers who recalled seeing Smiling Sun promotional material were more likely than those who did not to complete DPT vaccination (64% vs 48%). Marginal effectiveness remained positive after adjustment. Cost-effectiveness: National level data: $0.30/additional child vaccinated for measles and $0.36/additional child with DPT3. Local promotional activities: $32/additional child vaccinated for measles and $37/additional child vaccinated with DPT3.
Andersson 2009 [6]	Lasbela Pakistan parents of 12-23 months old	Three structured discussions with one in every ten thousand respondents. 1) Discussion showed findings about vaccine uptake from baseline survey. 2) Focused on the costs and benefits of childhood vaccination. 3) Focused on local action plans, including options for sharing transport and childhood costs.	1) Cluster randomised controlled trial. 2) Quality rating in Table 3.	Uptake of measles and full DPT vaccination.	Measles OR 2.20 (95% CI 1.2-3.88) DPT OR 3.36 (95% CI 2.03-5.56).

Table 3 - Methodological quality of systematic reviews and randomised trials primary studies included in this study.

Systematic review	AMSTAR	Quality Score (Percent of maximum)	Primary study	SIGN 50*	Percent quality
Pegurri et al 2004 [3]	1. No 2. No 3.Yes 4. No 5. No 6. No 7.Yes 8. No 9.Can't answer 10. No 11. No	18%	Brugha 1996 [22]	6/10	60%
Batt 2004 [14]	1. No 2. No 3.Yes 4.Yes 5. No 6. No 7.Yes 8.Can't answer 9.Can't answer 10. No 11. No	27%	Andersson 2008 [6]	6/10	60%
Haines 2007 [15]	1. No 2. No 3.Yes 4. yes 5. No 6. No 7. No 8. No 9. No 10. No 11. No	18%			
Ryman 2008 [5]	1. No 2. No 3.Yes 4.Yes 5. No 6.Yes 7.Yes 8. No 9.Can't answer 10. No 11. No	36%			

* Scores based on the first 10 items (internal validity) of the SIGN 50 Instrument http://www.sign.ac.uk/guidelines/fulltext/50/checklist2.html.

records are unreliable, this study used self-reporting, not vaccination records (discussed by the authors in Table 2). The evaluation of the Philippines program did not include an assessment of cost-effectiveness.

Hutchinson and others [17] described the 'Smiling Sun' multi-media campaign in Bangladesh between 2001 and 2003. A 26-episode television drama series featured recognisable local actors and intertwined drama and themes related to maternal and child health, family planning and communicable disease control (including vaccination). Episodes were followed by discussion and quizzes with prizes. The campaign included TV and radio promotions, posters, billboards, advertisements in newspapers and local publicity activities. At the community and clinic levels there were group meetings, rallies and loudspeaker announcements with campaign logos widely displayed. Two household surveys in 2001 and 2003 examined three outcomes: antenatal care, DPT3 and measles vaccination in children 12-35 months.

About one half of the respondents recalled seeing 'Smiling Sun' messages and, in the unadjusted analyses, this exposure was strongly associated with use of health

services. Mothers recalling the campaign were more likely than those who did not to report DPT3 vaccination (64% versus 48%) and measles vaccination (79% versus 61%). The authors recognized that better off mothers were more in touch with the media and more likely to access health services. Their multivariate analysis attempted to test "pessimistic assumptions" under which they estimated the campaign increased vaccine coverage by 20% among those who could recall seeing promotional material. Although compatible with a positive impact, the evaluation design precludes firm conclusions about causality. They included detailed costing of the media campaign: the incremental cost effectiveness ratios were $0.30-0.36 per additional child vaccinated, compared with $32-$37 per additional child vaccinated for local publicity campaigns. The latter may be due to the high incremental costs of local promotional activities, including billboards and rallies.

Cutts and others [20] report on door-to-door canvassing for a vaccination program intended to accelerate the expanded program on vaccination in Mozambique. The initiative sought to increase uptake of vaccination services through three household visits by volunteers from grassroots organizations. Door-to-door canvassing established a 'census' of children and mothers requiring vaccination. They reported increased measles vaccination coverage between 1% and 31% in different towns that applied the scheme. They provide no cost estimates and do not try to quantify the cost transferred to the communities through the volunteers.

Tulchinsky and his colleagues [21] tested 'village-resource rooms' to provide a variety of preventive-oriented services (information about well baby visits and mass vaccination programs) in Hebrun, West Bank. The staff also carried out general health education activities in the community, aimed at improving the knowledge of new mothers. The intervention did *not* increase the vaccination uptake although they claimed the project met other goals: better access to and utilization of preventive health services. They do not provide costing data.

Andersson and colleagues [6] carried out a randomised controlled trial in Lasbela, one of the poorest districts of Pakistan. Interviewers contacted houses of children under the age of 60 months for the baseline and follow-up surveys. The intervention involved three rounds of discussion about vaccination with "opinion makers" in each of the randomly selected villages. These discussions included one in every ten potential respondents in the intervention clusters, not necessarily those who did respond to the questionnaires. The first round of discussion dealt with issues of access, the second discussed costs of illness and vaccination, and the third considered local options and solutions. The authors anticipated these discussions would roll on from the narrow contact base to other parents in the intervention clusters. Relying on self-reporting by mothers, they reported significantly higher measles and DPT vaccination uptake in intervention than in control clusters. The impact of this KT — 20% increase in measles and 28.5% in full DPT — indicated a high level of effectiveness of their three-visit evidence-based dialogue. The authors estimated the scheme could be expanded to cover the whole district for $9 per child included. Since the coverage with measles vaccination was low (around 50%) even with the intervention, this implies a cost of around $36-45 per additional fully vaccinated child.

Incentives and other non-KT demand-side interventions

Collateral-free credit to poor women may improve their autonomy and capacity to care for their families. The interactions between thus empowered women could lead, in the logic of these initiatives, to social changes like increased uptake of vaccination. Amin and Li [18] looked at vaccination in villages where five NGOs provided microfinance. Their cross sectional survey found lower rates of infant mortality and modestly higher rates of vaccination among credit members than among non-member in the same area: last born vaccinated DPT3: 88.6% credit members, 82.1 non-members from the same district and 73.4% in non program districts. In the case of measles coverage: 67.8% for credit members, 58.8 for non-members in the same districts and 49.4% in non-program districts. Logistic regression analysis showed a significant relationship between credit membership and completion of vaccination. The study design did not permit firm conclusions about the causal nature of this intervention. There was also a strong relationship between vaccine coverage and infant death rates (< five years of age).

A second incentive study considered provision of food rather than credit. Loevinsohn and Loevinsohn [19] described a program in north-west Nicaragua where 19% of children under six years of age were malnourished. The mid 1980s saw establishment of well child clinics, some of them mobile. Stationary and mobile clinics introduced food supplements in 1985; every child who attended a clinic was entitled to 3.2Kg of flour, 0.9Kg of skim milk powder, one litre of cooking oil and three cans of chopped beef or pork. This was equivalent to three to five days of wages (or 3 to 7% of income if provided every three months). The authors found mobile clinics with food gifts achieved attendance rates of 99%, compared with 94% in stationary clinics with food, and 63.3% with regular mobile clinics. The assumption is that well child clinic attendance translates as completed vaccination. In the case of stationary clinics, attendance dropped with increasing distance to be travelled.

Brugha and Kevany [22] used a cluster-randomised design in Ghana to investigate the impact of an outreach intervention consisting of a home visit and referral note to a vaccination clinic followed by repeated visits by nurses to households of children who did not complete their vaccination schedule. Completed vaccination rose by 26.5% in the intervention group, compared with 6% in the control group ($P<0.005$). Although this project appeared to involve little in the way of knowledge transfer or translation, the home visits by nurses aimed to increase uptake of vaccination, rather than to deliver vaccination in the home. We felt it important to include this study because it employed a rigorous evaluation methodology.

Discussion

Our searches, including published systematic reviews and original studies, retrieved only eight published reports of controlled evaluations of the benefits and costs of interventions designed to increase demand for routine childhood vaccination. All of these studies showed some increases in uptake of vaccination, indicating that improvements of 10 to 20% are readily achievable.

The main approaches exemplified by these studies were knowledge transfer and provision of incentives and collateral-free credit. Having reviewed this body of data our main conclusion is that, despite their potential, and some encouraging results, interventions to increase demand for routine childhood vaccination have not been adequately investigated.

From a quantitative evidence based perspective, the level of evidence represented in the studies reviewed here is generally low, with a reliance on 'before and after' designs, employing repeated cross sectional surveys or retrieval of routinely collected data. It should be noted that the survey methods employed in some of these studies were of high quality and some authors made adjustments for variables that might act as confounders. However, the lack of concurrent control groups leaves most studies open to the possibility of 'order effects' (such as contemporaneous improvements in service provision) as an explanation for the findings. Attributing cause and effect is therefore difficult. This is disappointing, as the effect sizes seen in some studies were quite substantial. Furthermore, the variety of interventions and the lack of rigorous evaluations precluded any attempt to compare the effectiveness of the different approaches.

Thus, despite the crucial importance of the topic, interventions that increase demand for vaccination have received little research attention, in comparison with service enhancement approaches to increase vaccination coverage. Strategies that depend on use of the mass media do not lend themselves to evaluation by controlled trials as one cannot easily randomise exposure. They will not be effective if families are unable to access mass media – for instance in rural and remote areas. There is also the real issue of how long any effects of such campaigns last. To date, follow up times have been brief. We can speculate that the effects of mass media campaigns (on their own) will not last long compared with interventions that use education and reinforcement to engender basic changes in community attitudes to routine childhood vaccination.

Of course, the major challenge is to achieve such a sustained change. In our view this probably requires a shift from 'knowledge transfer' to 'knowledge translation', as defined in the Methods section. In this review we found no true example of an intervention that met the definition of 'knowledge translation'. But a realistic middle ground could be the type of village level discussions that we trialled in Pakistan [6]. This was facilitated by trained and paid fieldworkers with roll-on of the discussion after the team had left. In the Pakistan example, the main impact was anticipated from the social networking that followed the "paid intervention", in the form of three visits and discussions with opinion makers.

As illustrated in the studies reviewed here, demand side interventions can involve interventions that do not rely primarily on translation of knowledge. Collateral-free loans to women lead to empowerment and can result in collective actions, which can free up resources and overcome financial and logistical barriers to childhood vaccination. In this review the study by Loevinsohn [20] found in Nicaragua that food might provide an incentive to mothers to bring their children for vaccination. However, it is also likely that provision of food frees up other household resources and makes it easier for parents to organise vaccination visits. So it is equivalent to a financial payment.

The data on cost effectiveness were sparse, but indicated that demand side interventions are sometimes capable of providing incremental cost effectiveness ratios of less than $1 per additional fully vaccinated child. However, these low figures are very context specific as shown by the mass media campaign in Bangladesh [18,19] where the cost effectiveness ratios were between $30 and $40 per additional vaccinated child with local media campaigns, because of their higher net costs and lower coverage. There are many difficulties in attributing costs accurately to field activities. For instance, in volunteer based door-to-door interventions, like those in Mozambique, most of the true cost is absorbed by the volunteers, making the sustainability and reproducibility of the intervention questionable.

There are a number of important limitations in our work. One weakness of our review is that we did not update the

extensive grey literature review undertaken by Batt and others (2004) [14]. This was a matter of resources – Batt and colleagues relied on an extensive series of interviews with key informants and we were unable to reproduce these. However, the grey literature reported in the systematic reviews included here was up-to-date and reflected complex interventions aimed at strengthening health systems, rather than the demand-side interventions reported in the published literature [14].

The work reported here was very much an update of previous reviews – and therefore depends on the foundational work done by others. Another limitation of our work was the impossibility of doing a meta-analysis, so we are left to present disaggregated results in the form of a narrative.

The overriding limitation of the review is the sparseness of the literature on increasing the demand for vaccination; this is of concern given the importance of the topic. To provide sustained effects demand side interventions will have to be integrated with other system-wide approaches and will not work unless procurement and supply are also addressed adequately.

Conclusions

In the case of childhood vaccination, demand side interventions have been poorly investigated in developing countries. Even accepting the difficulties of carrying out research in this field, the available studies contribute only low levels of quantitative evidence. Recognising these limitations, the published studies reviewed here reported positive results, some claiming quite large increases in demand for childhood vaccination. However, the limited methodologies precluded any attempt to compare and contrast the effectiveness of different approaches. Mass media campaigns may be effective, but this will depend on access to media and may be costly if run at a local level. The studies reviewed here do not provide information on the duration of positive effects of mass media campaigns. The cost-effectiveness of demand side interventions has not been adequately assessed, but based on limited data some may prove to be very cost-effective.

List of abbreviations used

CHW – Community health worker; FVC – Full vaccine coverage; KT – Knowledge Translation.

Competing interests

The authors would like to declare two potential 'perceived risks of bias'. 1) Two of the authors (NA, BS) were involved in the Pakistan study, which is reviewed here. This review was conducted to assist with the development of the evidenced-based instruments used in the Pakistan trial. 2) Two of the authors (NA, BS) were involved in the development of AMSTAR and the third author (DH) assisted with the validation process.

Funding for this work came from the International Development Research Centre (IDRC) under grant 102172-007. The views expressed are those of the authors and do not necessarily reflect the views of IDRC.

Authors' contributions

BS, DH and NA did the original conceptual development. BS and DH performed the literature search, data and quality assessments. BS, DH, and NA prepared and assisted with the manuscript.

Additional material

Additional file 1

A measurement tool to assess systematic reviews (AMSTAR).
Available from:
http://www.biomedcentral.com/content/supplementary/1472-698X-9-S1-S5-S1.doc

Acknowledgements

This work was carried out with the aid of a grant from the International Development Research Centre (IDRC), Ottawa, Canada, as part of the Canadian International Immunization Initiative Phase 2 (CIII2). This initiative is a project of the Global Health Research Initiative (GHRI). The authors thank Linda Devore at the Institute for Clinical and Evaluative Sciences, Toronto for designing the search strategy and conducting the literature search.

This article is published as part of *BMC International Health and Human Rights* Volume 9 Supplement 1, 2009: The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants. The full contents of the supplement are available online at http://www.biomedcentral.com/1472-698X/9?issue=S1.

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Knowledge synthesis of benefits and adverse effects of measles vaccination: the Lasbela balance sheet

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from The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants

Published: 14 October 2009

BMC International Health and Human Rights 2009, **9**(Suppl 1):S6 doi:10.1186/1472-698X-9-S1-S6

This article is available from: http://www.biomedcentral.com/1472-698X/9/S1/S6

Abstract

Background: In preparation for a cluster-randomized controlled trial of a community intervention to increase the demand for measles vaccination in Lasbela district of Pakistan, a balance sheet summarized published evidence on benefits and possible adverse effects of measles vaccination.

Methods: The balance sheet listed: 1) major health conditions associated with measles; 2) the risk among the unvaccinated who contract measles; 3) the risk among the vaccinated; 4) the risk difference between vaccinated and unvaccinated; and 5) the likely net gain from vaccination for each condition.

Results: Two models revealed very different projections of net gain from measles vaccine. A Lasbela-specific combination of low period prevalence of measles among the unvaccinated, medium vaccination coverage and low vaccine efficacy rate, as revealed by the baseline survey, resulted in less-than-expected gains attributable to vaccination. Modelled on estimates where the vaccine had greater efficacy, the gains from vaccination would be more substantial.

Conclusions: Specific local conditions probably explain the low rates among the unvaccinated while the high vaccine failure rate is likely due to weaknesses in the vaccination delivery system. Community perception of these realities may have had some role in household decisions about whether to vaccinate, although the major discouraging factor was inadequate access. The balance sheet may be useful as a communication tool in other circumstances, applied to up-to-date local evidence.

Background

In early 2005, preparations began for a cluster-randomized controlled trial of a knowledge translation (KT) intervention to increase the demand for measles vaccination in Lasbela district of Balochistan province, Pakistan. Separate articles discuss the protocol [1], baseline findings [2], and the outcome of the trial [3].

The team worked from a defined theoretical position. We assumed that household decisions are fundamentally rational, at least in the sense that families weigh up costs and benefits of having their children vaccinated [4-6].

Early in the planning stages for the trial, well before conducting and analyzing the baseline survey, we expected to encounter concern over the potential adverse effects of measles vaccine. Previous work on child vaccination in the region had encountered a number of negative views. There was also a small but important international literature on the subject. Three majority-Muslim States in Nigeria at one time or another stopped internationally sanctioned polio vaccination campaigns based on conspiracy theories that the vaccination was a Western plot to sterilize children and even spread HIV among them [7]. In Europe and North America concerns about possible connections between the MMR vaccine and autism had been circulating in the media for years [8].

If these or similar concerns were raised at community level in Lasbela, we anticipated they would have to be addressed with full and accurate information. We prepared for this KT by designing a tool for discussing with the communities specific gains and losses to be anticipated from measles vaccination – the Lasbela Vaccination Balance Sheet.

The balance sheet went through a series of steps that are diagrammed in the left-hand column of Figure 1. Our first step was to gather the necessary data from developed-country sources from which almost all available estimates of measles complication rates and vaccination adverse effects are derived. After drawing up the balance sheet based on these estimates we then added parallel estimates for the major adverse effects under local conditions using whatever data were available on Lasbela, Balochistan, Pakistan or South Asia prior to our own baseline survey. The results of these steps are combined in Table 1. Outcomes of the baseline survey obliged us to modify our assumptions and recalculate the balance sheet. The main differences between our estimates prior to and after the baseline survey are presented in Table 2.

Methods

A balance sheet synthesized published information on risks of adverse effects of vaccination and risks for the same outcomes as complications of naturally occurring measles. We presented the difference in risk of each outcome between vaccinated and unvaccinated children as the risk difference (RD). Where the literature provided a range for the unvaccinated, we used the lower figure in the calculation. The inverse of the RD is the number needed to treat (NNT), the number of persons that must be vaccinated in order to avoid one case of the negative outcome, and the number needed to harm (NNH), the number that must be vaccinated to produce one case of harm.

We presented the data in terms of "gains," the potential number of cases of the outcome (or complication) prevented if all children currently unvaccinated were vaccinated for measles. The gain is calculated by multiplying the RD by the proportion requiring the intervention (PRI) and adjusting for vaccine efficacy [9].

The first model of expected gains used our original assumptions about conditions in Lasbela, before analysis of the 2005 baseline survey. We applied a PRI of 0.76 based on the overall vaccination rate reported for Balochistan province in 2001-02 according to the Pakistan Integrated Household Survey, Round 4 [10]. We assumed a vaccine efficacy rate (VER) of 90%, which is at the low end of estimates provided in the literature for developed countries [11].

For adverse effects, we consulted a 2005 comprehensive review of measles, mumps and rubella (MMR) vaccine effects published by the Cochrane Collaboration [12]. Of 31 studies that met the Cochrane review's inclusion criteria, we selected those 20 that contained specific numbers of adverse effect cases together with the total study population [13-32]. We extracted these data to create tables for each adverse effect (AE table) in a spreadsheet workbook.

We linked the rate of occurrence for each adverse effect in the table to the appropriate cell in the summary balance sheet. Due to time and resource constraints we did not assign credibility weights to each study. A summary rate of occurrence is derived from the total of adverse event cases divided by the total of the study populations reported by our sources for each adverse effect. Where there were no population-based AE data to match with a known complication of naturally occurring measles we use rates estimated by Duclos and Ward [33].

To obtain complication rates among the unvaccinated with measles, we consulted World Health Organization (WHO) documents [34-36], a standard textbook on the subject [37] and the sources these cited. Most sources for complication rates among the unvaccinated provide figures based on conditions in the developed world,

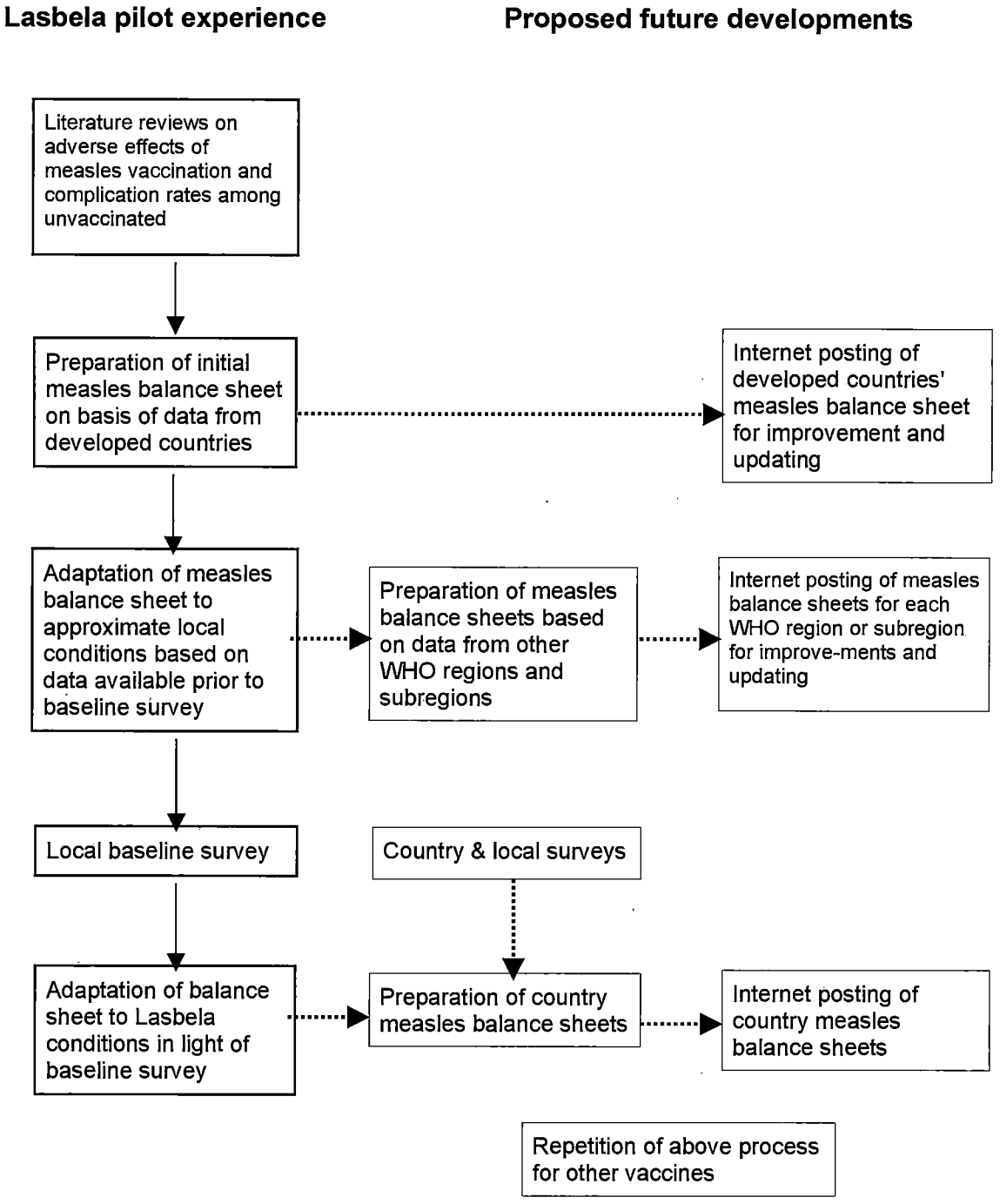

Figure 1 - Model of measles balance sheet development.

although some sources add broad estimates for rates of certain conditions in the developing world. In order to develop figures approximating conditions in Pakistan, we adjusted the complication rates for pneumonia and diarrhoea using regional incidence rates for these diseases (from all causes) based on data reported by WHO [38]. Pakistan is part of WHO's Eastern Mediterranean Region (EMRO), mortality substratum D. We calculated the rates of incidence of pneumonia (lower respiratory infections) and diarrhoea for EMRO-D and used European region substratum A as a comparison.

The adjustment for pneumonia applies the proportional difference in incidence rates for lower respiratory infections

Table 1 - Original Measles Vaccination Balance Sheet.

(1) Condition	(2) Measles complication rate among unvaccinated[a]	(3) Vaccine adverse event rate	(4) Risk Difference	(5) Number Needed to Treat (NNT)	(6) Expected Gain per thousand[e]
Diarrhoea in highly developed countries	0.08	0.0357	0.0443	23	30
Diarrhoea – WHO South Asia subregion adjusted	**0.41**	**0.0045**	**0.4055**	**3**	**277**
Bronchopneumonia in highly developed countries	0.01-0.06	0	0.01	100	7
Bronchopneumonia – WHO South Asia subregion adjusted	**0.089-0.53**	**0**	**0.089**	**11**	**61**
Blindness (Africa)	**0.04**[b]	**0**	**0.04**	**25**	**27**
Otitis media	0.07–0.09	0.0333	0.0367	27	25
Death in highly developed countries	0.001–0.003	0.0002	0.0008	1,189	0.6
Death – WHO South Asia subregion data	**0.0228**	**0.0002**	**0.0208**	**50**	**14**
Death in developing world (by some estimates)	15%	0.0002	0.1498	7	102
Convulsions	0.006–0.007[c]	0.0022	0.0038	266	3
Post-infectious encephalitis	0.001–0.0005	0.0004	0.0006	1,591	0.4
Subacute sclerosing panencephalitis (SSPE)	0.00001	0	0.00001	100,000	7/million
Anaphylaxis	0[d]	1–3.5 per million	–0.000001	–1,000,000	–7/ten million

[a] Except where noted all figures in this column taken from Strebel et al [44]. [b] [45]. [c] [51]. [d] [33].
[e] Gain=RDx(PRIxVER), where RD=risk difference, PRI=proportion requiring intervention (0.76),VER=vaccine efficacy rate (0.90).
The bold-font rows show the conditions for which the data are most applicable to the South Asia region or, at least, developing country conditions - diarrhoea, pneumonia, blindness and death.

Table 2 - Anticipated population gains and losses – cases of the condition prevented or caused if all children currently unvaccinated were vaccinated[a].

Condition	Expected gain (number prevented) under original assumptions	Expected gain (number prevented) applying efficacy rates from Lasbela baseline survey[b]
Diarrhoea	**277 per thousand**	**30 per thousand**
Bronchopneumonia	**61 per thousand**	**7 per thousand**
Blindness	**27 per thousand**	**3 per thousand**
Otitis media	25 per thousand	3 per thousand
Death	**14 per thousand**	**15 per ten thousand**
Convulsions	3 per thousand	3 per ten thousand
Post-infectious encephalitis	4 per ten thousand	5 per hundred thousand
SSPE	7 per million	7 per ten million
	Losses (original assumptions)	Losses after baseline survey
Anaphylaxis	7 per ten million	7 per hundred million

[a] Sources for all calculations are the same as in Table 1. Differences in gains are due to revised assumptions following the baseline survey.
[b] Gain=[RDx(PRIxVER)] x 0.361, where RD=Risk difference, PRI=proportion requiring intervention (0.49), and VER=Vaccine efficacy rate (0.415).
The bold-font rows show the conditions for which the data are most applicable to the South Asia region or, at least, developing country conditions - diarrhoea, pneumonia, blindness and death.

(from all causes) for the Euro-A and EMRO-D substrata (EMRO-D (42,687/351,256=0.12) Euro-A (5,649/412,512=0.01). The EMRO-D rate is 12 times the Euro-A rate (0.12/0.01). We used the same procedure for diarrhoea (EMRO-D (345,605/351,256=0.98) Euro-A (79,219/412,512=0.19). The EMRO-D incidence rate is 5.2 times that of Euro-A (0.98/0.19). The balance sheet reports figures for the base rate (developing world conditions) and EMRO-D adjusted rates (Pakistan conditions) for diarrhoea and pneumonia.

For a closer estimate of deaths due to naturally occurring measles in Pakistan, we divided the number of measles deaths for the year 2002 in WHO's EMRO-D region (70,392) [39] by measles incidence in that region (3,079,000) in the same year [40]. The rate thus derived is almost certainly underestimated. To provide an outer limit closer to reality in Pakistan, we also included gains calculations based on a death rate of 15%, which was suggested in other sources consulted as appropriate for developing countries [41]. It was assumed that virtually all the unvaccinated were likely to contract measles. In this we followed White and colleagues who reported that, according to United States records from the period previous to the introduction of measles vaccine, 95% of individuals in an unvaccinated population had evidence of measles infection by age 30 [42]. The vast majority of these infections are likely to have occurred in early childhood.

Blindness is usually reported as a complication of measles in the developing world, though not in the developed world. No base complication rates for the developing world were provided in any of the sources consulted. It

appears that little of the research on blindness in the developing world is population-based [43]. We found a single source that provided population-based rate of blindness as a complication for measles in Africa [44]. Despite the geographical and social difference with Pakistan we included it in the balance sheet as our only point of comparison.

Adverse effects among the vaccinated

Some adverse effects of measles vaccination did not appear in any of the sources as complications among the unvaccinated with measles. Most of these are local and/or mild reactions (e.g. fever, rash, redness, swelling, etc.), but some, such as anaphylaxis, though rare, do appear to occur among the vaccinated more than among naturally occurring measles cases. Another rare adverse effect is idiopathic thrombocytopenic purpura (ITP). We did not include it in the balance sheet because it seems to be associated with MMR vaccine rather than monovalent measles vaccines used in Pakistan [33]. Other reported adverse effects, lacking evidence of causal association, include Reye's syndrome, oculomotor palsy, optic neuritis, retinopathy, hearing loss, cerebellar ataxia, arthralgia, arthritis, soft tissue reactions, and Guillain-Barre syndrome. The sources consulted also reported certain "described" complications, but without rates of occurrence. These include thrombocytopenia, laryngotracheo-bronchitis, stomatitis, hepatitis, appendicitis and ileocolitis, pericarditis and myocarditis, glomerulonephritis, hyopcalcemia and Stevens-Johnson syndrome [44,45].

The articles from the Cochrane review, our point of departure, did not report rates of death among the vaccinated (i.e. as an adverse effect). We used two cost-benefit articles that provided estimates for this group derived from their models [42,46].

Results

The original balance sheet

The summary balance sheet presented in Table 1 reproduces the summary worksheet of the spreadsheet workbook. [The workbook itself is available from the authors.] The bold-font rows of Tables 1 and 2 show the conditions for which the data are most applicable to the South Asia region or, at least, developing country conditions – diarrhoea, pneumonia, blindness and death.

The risk difference and its inverse (NNT) indicate the broad level of public health importance of measles vaccination, taking into account the adverse effects. In the case of anaphylaxis, there is a balance unfavourable to vaccination of about one in a million. Otherwise the balance favouring vaccination is clear: 277 cases of diarrhoea, 61 of pneumonia, 27 of blindness and 14 deaths prevented for every thousand children vaccinated.

After the baseline survey

Table 1 was based on a set of assumptions that did not prove to be valid in the case of Lasbela as revealed in the baseline survey [47].

Our concern at the design stage that fear of potential adverse effects of vaccination would be an obstacle to vaccination coverage proved to be unfounded. In the baseline survey, household decision makers were asked whether they had heard about bad effects of vaccination, whether they had seen bad effects of vaccination and whether they knew some of the dangerous or severe complications of measles. The answers to these questions, whether positive or negative, had no significant effect on the decision to have the child vaccinated or not.

Only 4% (118/3251) of decision makers had heard of any adverse effect of vaccination. Most of the adverse effects they mentioned were recognised ones, including fever and swelling or pain at the injection site. A few (less than 1%) mentioned things that are not recognised adverse effects of vaccination and among these only a handful mentioned "family planning" signifying the belief that vaccinations will make children sterile or cause them to have only female children in the future. Some 58% (1913/3299) of decision makers reported they knew about some dangerous or severe complications if measles were to get worse. Participants in many focus groups made it clear they knew how serious an illness like measles could be and they mentioned some of the potential consequences of measles, including death.

The baseline survey results also called into question three assumptions on which the data of our original balance sheet were based:

1. Unvaccinated children do not all get measles. The baseline survey found that only 36% of unvaccinated children under five years of age had contracted measles before their fifth birthday. Children from urban households – only about a quarter of the total sample – were more likely to have had measles than rural children (weighted OR 1.64 95%CI 1.36-1.97). When asked how common they thought measles was in their area most decision makers (91%; 3010/3314) said they thought it was rare.

2. Measles vaccination coverage in Lasbela was higher than the rate for Balochistan that we used in the original balance sheet. The PRI, estimated at 76% in our original balance sheet was only 49% according to the baseline survey.

3. The baseline survey revealed that the VER was 41.5%, less than half that assumed in the original balance sheet. The VER calculation is based on all children from 10 to 60

months of age at the time of the survey after excluding those who had measles before the age of 10 months, and children who were vaccinated only after having measles or within one month before having measles. The measles attack rate among vaccinated children (AR_v) in this group was 12.8% (255/1988) while the attack rate among the unvaccinated (Ar_u) was 21.9% (386/1759) [47]. We then derived the VER from the formula: $VER = 1 - (Ar_v/AR_u)$ [48].

Given these three realities, our original balance sheet considerably overstated the protection that vaccination would provide against the various conditions listed there, as can be seen from Table 2.

The proportions presented in the third column of Table 2 are based on the same risk differences as in Table 1, but the PRI is 0.49 instead of 0.76 and the VER is 0.415 instead of 0.90. Also, instead of assuming that virtually all unvaccinated children would contract the disease, we further adjusted the resulting gains to the proportion of unvaccinated children less than five years of age who ever had measles in Lasbela according to the baseline survey (0.361).

The real concerns of the communities

Lasbela parents, by and large, were convinced their children should be vaccinated. The baseline showed that 90% of those who make the decisions about vaccination within Lasbela families thought it was worthwhile, 8% did not know whether it was worthwhile or not and only 2% thought it was not worthwhile.

When decision makers were asked about the difficulties households may face in getting their children immunized, more than half reported that access was a problem either because there were no nearby facilities offering vaccination or vaccination teams did not visit (35%), or because of transport problems or poor roads (24%). When asked what would ensure that every child in the household was immunized nearly all responses were related to improving access (92%).

In the end, the balance sheet was not used as part of the Lasbela intervention. Instead, community discussions focused on the relative costs of treating measles cases versus the costs of preventing measles through immunization, as well as on the barriers to obtaining immunization services [3].

Discussion

Usefulness of the balance sheet

The balance sheet was not used as part of the intervention because possible adverse effects of vaccination were not a community concern. The major obstacle to improved vaccination rates in Lasbela proved to be the lack of access. We had anticipated greater concern over the potential adverse effects of measles vaccine than we encountered among Lasbela families. Both the baseline survey and discussions held with non-sample communities during the design phase of the intervention indicated clearly that belief in the efficacy of the vaccine was not a significant factor in household decisions; the overwhelming concern was about the costs of having children vaccinated. These were costs in time, transport and money, resulting in a tendency to postpone having one's child vaccinated and/or discount the likelihood that one's own child might fall prey to the disease [3].

Our theoretical position concerning the rationality of household decisions was too broad to be applicable in the concrete circumstances of Lasbela in 2005-2007. The household decision-making revealed in this experience corresponded more to Herbert Simon's concept of "bounded rationality" [49]. In the words of a contemporary heir to Simon's insights, "...the human mind makes many decisions by drawing on an adaptive toolbox of simple heuristics, not because it is forced to by cognitive constraints, but rather because these fast and information-frugal heuristics are well matched to the challenges of the ... environment"[50]. The environmental challenges most operative in the Lasbela situation were distance and poverty. Knowledge about vaccination was high, attitudes toward it were positive and there was a good deal of discussion within the household about vaccination, but there was little concern about possible adverse effects [2].

Still, people have a right to know about possible adverse effects of any vaccination. We believe that the relevant information should be available to those who request it and in a form that enables them to weigh costs and benefits – in terms of adverse effects and complications – of both being vaccinated and *not* being vaccinated. In other places and under other conditions the potential adverse effects of measles vaccine could be an important deterrent to vaccination. The balance sheet can provide the necessary information in a concise and useful form that will enable people and communities to make rational choices in this regard.

Vaccine failure

The objective of the Lasbela trial was to demonstrate that informed discussion of costs and benefits could improve demand for vaccination, without relying on improvements in health service delivery. An unvaccinated child still had twice the risk of contracting measles compared to one who was vaccinated. The Lasbela population evidently perceived this as a positive effect, but the odds in favour of vaccination could and should have been much higher.

The low vaccine efficacy indicates that some improvement in vaccine delivery is necessary. The failure rate of over 50% means a partial breakdown in the cold chain or, more likely, its inappropriate management at the point of delivery (for example, partially used multi-shot vials left open or in the light).

Measles among the unvaccinated

The relatively low rate of measles among the unvaccinated can be explained by the scattered and relatively isolated nature of communities in many rural areas of Lasbela. This apparently creates an environment less conducive to the spread of naturally occurring measles. This conjecture is reinforced by the somewhat higher rates among the minority of children in the denser urban areas [2]. Nine out of ten respondents thought that measles was a relatively rare occurrence in Lasbela and this, too, is likely to have influenced the household cost-benefit calculations about vaccination.

Limitations of the balance sheet

We were unable to find published data about complications among the unvaccinated or adverse effects of measles vaccination from Pakistan or anywhere in the South Asia sub-region. The extrapolations to South Asia for diarrhoea and pneumonia rates among the unvaccinated are crude estimates at best, based on ratios of diarrhoea and pneumonia occurrence for any cause between one large WHO region and another. Complication rates among the unvaccinated for otitis media, anaphylaxis, convulsions, encephalitis and SSPE reported are based only on developed country conditions, which are quite different.

The balance sheet does not allow for differences in the severity and duration of the conditions it lists. Measles vaccination is known to have a limiting effect in many cases on the severity and duration of common illnesses such as diarrhoea and respiratory disease, but such effects are not taken into account by this instrument. The rates recorded in columns 2 and 3 of Table 1 are for people of any age whereas our gains calculations apply only to children under five years of age. As the practice of generating balance sheets grows, these deficiencies could be improved upon.

We did not determine whether the adverse effects reported by our developed-country sources were reported before or after the introduction of a two-dose regimen for measles vaccine. The likelihood of at least some adverse effects should be higher in the developed countries where two doses is the norm than in developing countries like Pakistan where it is not.

We made no adjustments for vaccine strain. The studies we used for adverse effects came from a review of MMR vaccine. Adverse effects of single measles vaccine cannot always be easily isolated from those of the triple vaccine as reported in our sources. We did not weight the data from the different studies on adverse effects according to their risk of bias.

Conclusions

The balance sheet may be useful as a communication tool in many other circumstances, but it needs to be tested against up-to-date local evidence in other countries.

If the necessary resources become available, CIET hopes to develop and expand the balance sheet into a web-based tool accessible for critical peer review and eventual public use. We will first have to find ways to overcome as many of the limitations mentioned above as possible. Such a tool could be regularly updated with new research and become a timesaving reference for project managers and heath officials concerned with vaccination.

Figure 1 outlines a possible set of steps toward this end. Since most of the available data on vaccine adverse effects come from developed country sources, the logical starting point would be to post a developed-countries balance sheet and refine it based on critical comments and additional information. The long-term goal, however, should be to have a set of balance sheets for each developing country based on population surveys of measles occurrence. As an intermediary step balance sheets can be developed for WHO regions and sub-regions using data similar to those we used from the WHO South Asia sub-region in which Pakistan is located. Country surveys that include information about vaccine adverse effects will help gradually to improve the quality of these regional and sub-regional balance sheets as well.

Country surveys are also helpful for testing vaccine efficacy which, as we have seen, is crucial not only for the balance sheet but for the credibility of the entire vaccination enterprise.

List of abbreviations used

KT – Knowledge Translation; RD – Risk difference; NNT – Number needed to treat; NNH – Number needed to harm; PRI – Percentage requiring intervention; MMR – Measles, mumps and rubella; WHO – World Health Organization; EMRO – Eastern Mediterranean Region; VER – Vaccine Efficacy rate.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

JF researched the original balance sheet and drafted the methods section. NA designed the balance sheet and contributed to drafting the report. RJL drafted the report.

Acknowledgements

This work was carried out with the aid of a grant from the International Development Research Centre (IDRC), Ottawa, Canada, as part of the Canadian International Immunization Initiative Phase 2 (CIII2). This initiative is a project of the Global Health Research Initiative (GHRI). The views expressed are those of the authors and do not necessarily reflect the views of IDRC.

We also wish to thank the CIII2 supplement editorial board and reviewers for the helpful comments to a previous draft of this article.

This article is published as part of *BMC International Health and Human Rights* Volume 9 Supplement 1, 2009: The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants. The full contents of the supplement are available online at http://www.biomedcentral.com/1472-698X/9?issue=S1.

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Equity and vaccine uptake: a cross-sectional study of measles vaccination in Lasbela District, Pakistan

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from The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants

Published: 14 October 2009

BMC International Health and Human Rights 2009, **9**(Suppl 1):S7 doi:10.1186/1472-698X-9-S1-S7

This article is available from: http://www.biomedcentral.com/1472-698X/9/S1/S7

Abstract

Background: Achieving equity means increased uptake of health services for those who need it most. But the poorest families continue to have the poorest service. In Pakistan, large numbers of children do not access vaccination against measles despite the national government's effort to achieve universal coverage.

Methods: A cross-sectional study of a random sample of 23 rural and 9 urban communities in the Lasbela district of south Pakistan, explored knowledge, attitudes and discussion around measles vaccination. Several socioeconomic variables allowed examination of the role of inequities in vaccination uptake; 2479 mothers provided information about 4007 children aged 10 to 59 months. A Mantel-Haenszel stratification analysis, with and without adjustment for clustering, clarified determinants of measles vaccination in urban and rural areas.

Results: A high proportion of mothers had appropriate knowledge of and positive attitudes to vaccination; many discussed vaccination, but only one half of children aged 10-59 months accessed vaccination. In urban areas, having an educated mother, discussing vaccinations, having correct knowledge about vaccinations, living in a community with a government vaccination facility within 5 km, and living in houses with better roofs were associated with vaccination uptake after adjusting for the effect of each of these variables and for clustering; maternal education was an equity factor even among those with good access. In rural areas, the combination of roof quality and access (vaccination post within 5 km) along with discussion about vaccines and knowledge about vaccines had an effect on uptake.

Conclusions: Stagnating rates of vaccination coverage may be related to increasing inequities. A hopeful finding is that discussion about vaccines and knowledge about vaccines had a positive effect

that was independent of the negative effect of inequity – in both urban and rural areas. At least as a short term strategy, there seems to be reason to expect an intervention increasing knowledge *and discussion* about vaccination in this district might increase uptake.

Background

In health planning, a pro-equity approach requires the removal of obstacles to accessing services. However, inequities in many countries are increasing, leaving an ever widening gap between the rich and poor, and even dividing the poor into further gradients of vulnerability [1,2]. Expenditure on services is notoriously unbalanced, with the least vulnerable receiving the majority of investment [3]. This "poverty trap" means that the poorest and most vulnerable populations are less able to take up health care offers; this in turn worsens their socio-economic situation and health status [4,5].

Although there is debate about the definition of equity, there is a general consensus that health inequity constitutes inequalities in health that are unfair or unjust [6,7]. Rates of childhood vaccination are a good example. Vaccination is officially free in most countries, and in many developed countries its uptake is so close to universal as to have it considered "an indicator of how well children's rights are being respected" [8]. But vaccination coverage is lower in most developing countries, particularly in the poorest segments of these countries. Although vaccination is theoretically free, this does not account for costs of travel to the facilities and time away from work or the home. Poor access to facilities providing vaccination is a common reason for low uptake [9-11]. Other factors associated with reduced vaccination uptake include lack of maternal education [12], large family size [13], lack of household visits from health workers [14], and service provision issues such as a poor relationship between staff and clients and lack of trust that the vaccine is safe [15]. These disadvantages may be increased in vulnerable areas by, for example, water shortage, in comparison with which vaccination may not seem a pressing need [16]. Compounding reduced vaccination uptake, children from vulnerable households may have weaker immune systems and therefore be at increased risk of suffering severe consequences from measles [17]. In Bangladesh, for example, an unvaccinated child from a poor family in 2001 was more than twice as likely to die as an unvaccinated child from a family of higher economic status [18]. The costs of not vaccinating against measles have different implications for wealthier households for whom, with much less malnutrition and concomitant illness, childhood measles presents little more than an inconvenience [19].

Measles, a disease preventable by vaccination, primarily affects children in developing countries. According to the World Health Organisation (WHO) in 2001 there were over 30 million cases of measles and 777,000 deaths worldwide [20]. In Pakistan, estimates show that 20,000 children die from measles annually [21,22]. This is despite the Pakistan Expanded Programme on Immunization (EPI) which provides BCG, DPT, polio vaccine, and measles vaccine during the first year of a child's life. According to the Pakistan Ministry of Health, the programme is aiming for "90% routine immunization coverage of all EPI antigens with at least 80% coverage in every district by 2012" [23]. There is evidence suggesting that measles vaccination coverage has increased only slightly or even stagnated in some provinces in the last few years [24-26]. According to the Pakistan Social and Living Standards Measurement Survey (2006-07), for example, measles vaccination in Balochistan province fell from 70% in 2006 to 54% in 2007 [27].

To examine uptake of measles vaccination, we conducted a household survey in Lasbela, an impoverished district in the south-east corner of Balochistan province of Pakistan, in 2005. Using data from this survey, we have examined the factors related to measles vaccination uptake and in particular the role of inequities in determining this uptake.

Methods

Sample and data collection

At the time of the sample selection, Lasbela district consisted of five tehsils and had 22 union councils – 5 urban and 17 rural (the sampling and data collection took place before the addition of newly created tehsils, now totalling nine). We selected a stratified random cluster sample of communities to give representation of the situation in the different tehsils or talukas. First, union councils were randomly selected from each tehsil, reflecting urban/rural spread and with the number according to the population in each tehsil. We included a minimum of four union councils per tehsil to allow for tehsil level findings if needed for district level planning purposes. The official list of union councils provided by the district government was used as the sampling frame for the selection of union councils. From each union council we randomly selected one community (village or mohalla) from the list of communities in the union.

We drew a stratified random sample of 23 rural and 9 urban enumeration areas in Lasbela district to allow adequate representation of the heterogeneity across the

district - particularly to allow tehsil level representation and urban/rural differentiation. In each selected community, the sample included a group of 100 contiguous households with children under five years, spreading out from a random starting point. There was no sampling within the site; all the eligible households were included.

Data collection instruments included a household questionnaire, which asked about household demographics and socio-economic status, and a questionnaire for the mothers or caregivers of children under 60 months old, which asked about the mothers' education, vaccine related knowledge, attitudes and practices, and about vaccination and illnesses of the children. The field teams also completed community profiles for each village of each community, by means of discussion with knowledgeable people and their own observations, including information about the location of facilities providing vaccination services and visits from mobile vaccination teams. It is possible for there to be different results within each community for this data as the community profiles were completed at the village level. For some indicators (i.e. visits by a vaccination team) there was missing data in the community profile for some villages, therefore reported denominators for these variables are smaller than variables from the household questionnaire.

Field teams comprising mainly women interviewers undertook the household survey in March and April 2005. After preliminary analysis of the household data, the teams returned to all of the sample communities in July 2005 and discussed the findings. Separate male and female focus group were conducted in each sample community [11].

Analysis

Data entry used the public domain software package EpiInfo [28]; double data entry with validation reduced keystroke errors. Analysis relied on CIETmap open source software [29,30]. Although the sample drawn from each tehsil reflected its relative population size, this was not exact. To take into account under- and over-sampling of tehsils, we calculated population weights and applied these when making district level estimates. All the district level estimates reported in this article are weighted.

We examined associations between measles vaccination (among children aged 10-59 months), and related factors using the Mantel Haenszel procedure [31]. We first tested crude associations in a sequential analysis (stratifying by one factor at a time) and then used a multiple stratification – analogous to logistic regression analysis [32] – stepping down from an initial saturated model. Final results are presented as adjusted Odds Ratios (OR) and 95% confidence interval. Initial sequential stratification revealed that the associations between many of the variables and measles vaccination were different between urban and rural communities. We therefore built separate models for urban and rural settings.

In order to adjust for clustering, we applied Gilles Lamothe's robust variance estimator for cluster-correlated data to the Mantel-Haenszel stratification. Based on the odds ratio, the Lamothe estimator weights the effect rather than simply the in-cluster correlation. The adjustment works for medium and large data sets, where zero margins are not an issue.

Measurements of trend of vaccination uptake used the Mantel extension [33] calculated using the Statcalc module in Epi Info.

We used measles vaccination, as reported by the mother, as an indicator of vaccination coverage. In addition to uptake of measles vaccination as our primary outcome, we considered intermediate outcomes based on a behaviour change model called CASCADA, first developed in a study of HIV and AIDS prevention in 2001 [34] and subsequently used in developing an intervention to improve vaccination rates [24]. This model extends the knowledge, attitudes and practice model, adding more intermediate outcomes between knowledge and action. These include conscious knowledge (able to correctly identify an illness preventable by vaccination), attitudes (think it is worthwhile to vaccinate), subjective norms (neighbours think it is worthwhile to vaccinate), intention to change (willing to take time away from daily activities to vaccinate), agency (mother is involved in decisions about vaccination), discussion (discuss vaccinations within the household), and action (uptake of measles vaccination).

We defined several vulnerability variables to describe inequities between households and children that might be relevant to the uptake of measles vaccine.

Access: We divided children according to whether they lived within 5 km of a government facility offering vaccinations, and whether they lived in a community that was visited by a mobile vaccination team.

Type of roof: As a proxy for economic status we used roof quality, grouping roofs made of reinforced concrete, iron, asbestos or T-iron as good quality, and roofs that were thatched, mud or wood as poor quality.

Occupation of main breadwinner: Keeping in view the problems that are faced in asking directly about the household income, we used occupation of the main breadwinner as a proxy to the household economic status. We then grouped the households into those where the main

Table 1 - Equity indicators among children aged 10-59 months.

	Percent (number)		
	Rural areas	Urban areas	p value
Mother with any formal education	3 (92/2730)	16 (199/1274)	<0.001
Live within 5 km of government vaccination facility	27 (815/2518)	84 (1031/1221)	<0.001
Live in community visited by a vaccination team	46 (1082/2328)	22 (279/1252)	<0.001
Mother visited by a LHW who talked about vaccinations	2 (80/2723)	19 (243/1258)	<0.001
Live in household with better roofs	25 (666/2728)	65 (787/1261)	<0.001
Live in household with better occupation of main breadwinner	50 (1383/2711)	53 (651/1246)	0.471
Live in less crowded household	37 (1013/2726)	49 (597/1261)	p<0.001

breadwinner had an occupation with a potential of better yield in terms of income (such as skilled workers and office work) and those with a relatively poor occupation (such as unskilled worker or unemployed).

Household crowding: We calculated room occupancy by dividing the number of household members by the number of rooms in the household. We classed households with room occupancy of four or more as crowded.

Education of the mother: The education and literacy of women in Lasbela is low. We categorised mothers and caregivers according to whether they had *any* formal education or not.

Household visits from a lady health worker (LHW): LHWs in Pakistan are an important source of preventive education and information for mothers. LHWs in Pakistan are considered as the prime source of preventive education and information to the households. They also counsel and motivate caregivers and household decision makers to immunize their children. We defined access to LHWs as mothers who had been visited by an LHW *and* who received information about vaccinations from the LHW.

Higher level variables: We generated higher level variables to test the combination of equity-related risk factors when these factors did not have a significant effect on their own. For example, in the rural multivariate model, we considered those who had the double disadvantage of poor access (further than 5 km from a government facility offering vaccination) and poor quality roofs.

Results

The survey covered 3366 households in total, and reached 2479 mothers who provided information about 4007 children between 10 and 59 months of age.

Vulnerability and equity factors

Less than one half (45%, 1846/3739) of children aged 10-59 months lived within 5 km of a government health facility offering vaccination services, and just over one-third (1361/3580) lived in areas visited by a vaccination team. Some 37% (1453/3989) of children aged 10-59 months lived in houses with good quality roofs; 51% (2034/3957) lived in houses where the main breadwinner had an occupation with better income; 41% (1610/3987) lived in less crowded households and 31% (1274/4007) lived in urban settings. Only 7% (291/4004) of children aged 10-59 months had mothers with any formal education. And only 8% (323/3981) had mothers that had been visited by a LHW and told about vaccinations.

Table 1 shows the different equity variables in urban and rural areas. More children in urban areas had mothers with some formal education (p<0.001). The proportion of children with access to government vaccination facilities within 5 km was much higher in urban areas than in rural areas (p<0.001). Vaccination team visits were higher in rural areas (p<0.001), although still less than one half of the rural children lived in communities visited by a vaccination team. The proportion of rural children whose mothers received visits and information about vaccinations from an LHW was low; only 2% of mothers received this information from an LHW.

Knowledge, attitudes and discussion about vaccination

Knowledge about vaccinations was high. Some 86% (2164/2474) of mothers had heard about vaccinations and 76% (1884/2438) could correctly mention an illness that could be prevented by vaccination. Only 3% of mothers (74/2437) had heard something about bad effects of vaccinations. Nearly all (91%, 2255/2450) mothers felt it was worthwhile to vaccinate children. Among those with knowledge about vaccinations, even more (98%, 1841/1881) felt it was worthwhile to vaccinate.

Most (82%, 2046/2451) mothers felt their neighbours would agree that it was worthwhile to vaccinate children. Among those who did not say this, many (296) said they did not know how their neighbours felt. Nearly all (94%, 1989/2092) mothers said they would be willing to take some time out of their day to take a child from their

Table 2 - Knowledge, attitudes and discussion of vaccination among mothers of children aged 10-59 months.

	Percent (number)		
	Rural areas	Urban areas	p value
Could correctly identify an illness preventable by vaccination	70 (1223/1692)	89 (661/746)	<0.001
Felt vaccinations were worthwhile	88 (1520/1694)	97 (735/756)	<0.001
Believed neighbours thought vaccinations were worthwhile	77 (1347/1695)	92 (699/756)	<0.001
Willing to take time to have child vaccinated	92 (1374/1468)	98 (615/624)	<0.001
Involved in decision about vaccinations	89 (1527/1715)	82 (624/754)	<0.001
Discussed vaccinations within the family	82 (1394/1676)	92 (696/753)	<0.001

Table 3 - Measles vaccination among children aged 10-59 months (urban areas).

	Percent (number vaccinated)	p value
Males	64% (410/636)	p=0.724
Females	63% (374/589)	
Live within 5km of vaccination facility	68% (692/1023)	p<0.001
Live further than 5km of vaccination facility	44% (91/190)	
Visited by vaccination team	66% (182/277)	p=0.575
Never visited by vaccination team	63% (617/966)	
Better roofs	66% (522/779)	p=0.007
Poor roofs	59% (281/473)	
Better job	67% (433/643)	p=0.007
Poor job	59% (356/594)	
Educated mother	87% (173/199)	p<0.001
Non-educated mother	59% (636/1065)	

Table 4 - Measles vaccination among children aged 10-59 months (rural areas).

	Percent (number vaccinated)	p value
Males	47% (672/1350)	p=0.053
Females	43% (617/1340)	
Live within 5km of vaccination facility	66% (551/811)	p<0.001
Live further than 5km of vaccination facility	38% (668/1674)	
Visited by vaccination team	51% (552/1064)	p<0.001
Never visited by vaccination team	38% (521/1232)	
Better roofs	57% (383/660)	p<0.001
Poor roofs	41% (908/2035)	
Better job	49% (706/1374)	p<0.001
Poor job	41% (575/1304)	
Educated mother	62% (59/92)	p=0.002
Non-educated mother	44% (1234/2605)	

household to be vaccinated. Most (87%, 2151/2469) mothers reported they were involved in decisions about vaccination, and most (85%, 2090/2429) mothers had discussed vaccination within the family. Knowledge, positive attitudes and rates of discussion were higher in urban areas than in rural areas (Table 2).

Inequity and measles vaccination uptake

Among children aged 12-23 months, slightly more than half (51%, 477/904) had received measles vaccine. Similarly, 51% (2103/3964) of the children aged 10-59 months had received the measles vaccine.

Tables 3 and 4 show the percentage of children aged 10-59 months vaccinated in urban and rural areas by different equity indicators. Notable is the fact that even among those in better socio-economic situations, in most cases only two-thirds of children are immunised. For example, in urban areas located within 5 km of a government vaccination facility, 68% (692/1023) of children aged 10-59 months are vaccinated. Similarly, among children in urban areas where the main breadwinner has a good job, 67% (433/643) are vaccinated. One exception to this is children from urban areas whose mothers' are educated (87% - 173/199).

Table 5 - Variables included in multivariate analysis of measles vaccination uptake among children aged 10-59 months.

Outcome:	Measles vaccination
Covariants:	Roof type
	Occupation
	Crowding
	Education of mother
	Rural/urban setting
	Sex of the child
	Mother could correctly identify an illness preventable by vaccination
	Mother discussed vaccination within the family
	Mother involved in decisions about child's vaccinations
	Mother visited by LHW and told about vaccinations
	Government vaccination facility within 5km of area
	Community visited by a mobile vaccination team

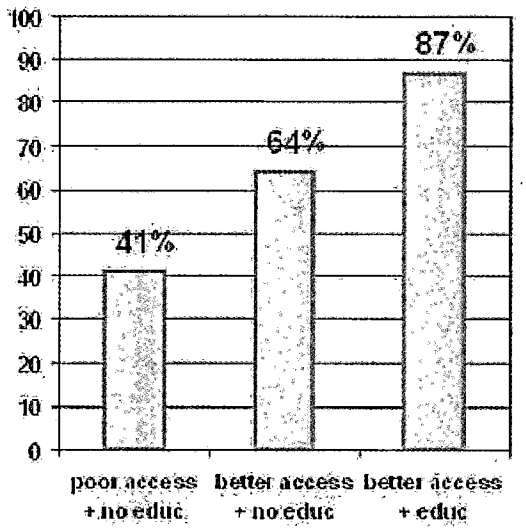

Figure 1: Proportion of children aged 10-59 months vaccinated among equity sub-groups in urban areas.

Table 5 shows the variables included in the multivariate analysis, to further investigate the role of equity and other behavioural indicators in vaccination uptake of children aged 10-59 months. Table 6 shows the final model of the multivariate analysis for children living in *urban* areas. Having a mother with some education, who had discussed vaccinations, who knew of at least one vaccine-preventable illness, living in a community within 5 km of a government vaccination facility, being visited by a LHW who talked about vaccinations, and living in a house with a good roof were associated with vaccination uptake.

Table 7 shows the final model of factors for children living in *rural* areas. The model included many of the same variables as in urban areas, with access to vaccination and roof of dwelling having a combined effect, where the individual effects were statistically insignificant.

Figure 1 illustrates the compounding effects of inequities in urban areas, showing the two most prominent equity factors that resulted from the urban multivariate analysis model – education and access. There is a significant trend for increased vaccination as inequities are removed (Chi square for linear trend 72.510, p<0.000). Among children living in households more than 5 km from a government facility providing vaccinations (poor vaccination access) and whose mother had no education, just 41% (75/173) had received measles vaccine. Among children with poor vaccination access and with mothers with some education, 64% (541/850) had received measles vaccine. Among children with the advantages of both better access to a vaccination facility and a mother with some education,

Table 6 - Multivariate model of factors associated with measles vaccination in urban areas.

Variable	Unadjusted OR	Adjusted OR	95%CI for adjusted OR	Cluster adjusted 95% CI for OR
Education of mother	4.46	3.59	2.33–5.55	**2.14–6.03**
Discussed vaccinations	3.80	3.13	2.04–4.82	**1.47–6.69**
Knowledge about vaccinations	3.71	2.57	1.74–3.82	**1.67–3.97**
Govt vaccination facility <5km	2.45	1.95	1.37–2.78	**1.63–2.34**
Good roof	1.41	1.47	1.12–1.93	**1.08–2.01**
Access to LHW	1.79	1.76	1.22–2.53	0.90–3.43

Table 7 - Multivariate model of variables associated with measles vaccination in rural areas.

Variable	Unadjusted OR	Adjusted OR	95%CI for adjusted OR	Cluster adjusted 95% CI for OR
Discussed vaccinations	6.42	4.17	3.10–5.61	1.19–14.64
Knowledge about vaccinations	3.50	2.22	1.78–2.78	1.36–3.63
Government vaccination <5km and good roof	3.19	3.7	2.41–5.19	1.85–5.64

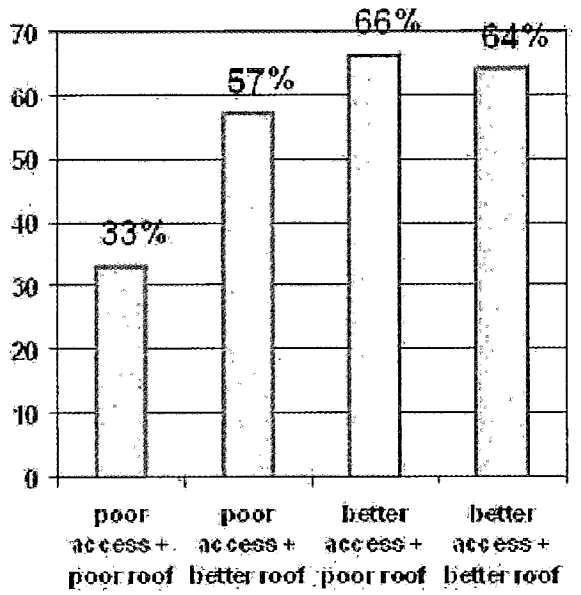

Figure 2: Proportion of children aged 10-59 months vaccinated among equity sub-groups in rural areas.

87% (151/173) had received measles vaccine. There were too few children with poor vaccination access whose mothers had any education to include this category in the figure.

Figure 2 illustrates the compounding effects of inequities in rural areas, showing two prominent equity factors that resulted from the rural multivariate analysis model – access and roof type. Again, there is a significant trend for increased vaccination as inequities are removed (Chi square for linear trend 204.001, p<0.000). Among children with poor vaccination access, those living in houses with a better roof were more likely to be vaccinated than those in houses with a poor roof (57% - 207/354 vs. 33% - 461/1320). Children with better vaccination access had higher rates of vaccination, and in this group there was little difference between those with a poor roof (66% (422/611) vaccinated) and those with a better roof (64% (129/200) vaccinated).

Views of community focus groups

When they heard about the low rates of measles vaccination in their area and discussed the reasons for this, most of the focus groups, both male (24/32) and female (23/32), stressed the problems of access to services. Some (17/32 males focus groups and 13/32 female focus groups) noted that people were ignorant or had misconceptions about vaccination, for example: *"Some people say that in earlier times children were never vaccinated, but they still managed to survive"* (Female focus group).

Yet the groups noted that immediate financial and time costs associated with having a child vaccinated weigh very heavily in comparison with the potential costs associated with measles in the future. Poverty was mentioned by 23/32 male focus groups and 25/32 female focus groups as a major reason why children weren't vaccinated. The focus group participants were clear that poverty was a major limitation to vaccination in the context of the limited access to vaccination services in Lasbela. Overwhelmingly, their suggestions for how to increase vaccinations were concerned with increasing access to services. For example: *"Vaccinations must be available at all basic health units so that more children may be vaccinated."* (Male focus group) and *"Teams must come here once every month and immunise our children."* (Female focus group)

Discussion

Measles coverage in Lasbela is unacceptably low, with only one half of the children aged 12-23 months old vaccinated. This is despite most mothers knowing of a vaccine preventable illness, considering vaccination worthwhile, and discussing vaccinations within the family. We found a strong association between discussion of vaccination and vaccination status in both urban and rural areas. Yet discussion is clearly not enough; vaccination rates in Lasbela are low even among the high proportion of mothers who had discussed vaccination in the family.

Among the limitations of this study is the reliance on vaccination as reported by the mother, as an indicator of vaccination uptake. Some developed country authors have suggested that maternal recall is not a good enough indicator of vaccination status compared with health facility records [20,21]. However, a study from Italy found that parental recall alone was similar to other measures of vaccination status and concluded that "verbal recall should be accepted as reasonably reliable in the absence of cards" [22], while in Australia parental recall of measles vaccination coincided as well as vaccination cards with the presence of antibodies [23]. In Turkey, taking polio antibodies as the 'gold standard', a study found that parental recall was more sensitive but less specific than official records [24]. A study in India found that maternal recall underestimated children's vaccination status but using vaccination cards was not helpful because less than half the mothers had cards and the cards were often incomplete or grossly inaccurate [25]. Our own experience in Pakistan is that vaccination cards are frequently missing or highly inaccurate. Valadez et al in Costa Rica concluded that maternal recall could be used for estimating vaccination status, especially for younger children and for single dose vaccines [26]. Langsten and Hill in rural Egypt found mothers' reports were later confirmed by card data for at least 83% of children aged 12-23 months [27]. Gareaballah and Loevinsohn found that mothers'

reports in the Sudan were accurate and concluded that for both DPT and measles vaccination, reliance on mothers' reports alone gave accurate estimates of vaccination coverage [28]. Goldman and Pebley in Guatemala highlighted the serious problems with service-based data (including vaccination cards) and recommended using mothers' reports to improve estimates of vaccination coverage [29]. Importantly, authors have reported that even if maternal recall may under- or over-estimate vaccination status, this was not related to factors such as maternal education level or poverty status [25,30]. We therefore believe that our reliance on maternal recall of vaccination status is reasonable and is not likely to have introduced bias into the analysis of factors related to vaccination in the Lasbela district.

Our findings illustrate the role of equity in determining vaccination uptake in Lasbela. In both urban and rural areas, access to a government facility providing vaccinations, a key equity factor, was a determining factor for uptake. This is consistent with other reports that identify poor access to vaccination services as an obstacle to uptake [9,10]. This was also confirmed during community feedback focus groups where many participants claimed their main obstacle to vaccinating their children was access to the facilities. In Lasbela, the proportion of children in rural areas with access to government facilities providing vaccination services is much lower than in urban areas and it is not universal even in urban areas.

In Lasbela we did *not* find visits by mobile vaccination teams associated with increased vaccination in either urban or rural areas. This is in contrast with the findings in other districts of Pakistan, where visits by vaccination teams were associated with increased measles vaccination, particularly in rural areas [35]. When asked how vaccinations might be increased, nearly all of the focus groups (29/32 male and 25/32 female) suggested *door-to-door* visits by the vaccination teams. It is likely that in Lasbela, where the terrain is mountainous and difficult to traverse, even when vaccination teams supposedly visit the community they are not reaching the most remote households in the communities. There could also be issues around service delivery (such as service provider attitudes, unofficial payments) that restrict the effectiveness of these initiatives.

In urban areas of Lasbela, where access to vaccination services is better than in rural areas, maternal education also played an important role in determining vaccine uptake, consistent with the findings of other authors [12,35]. However, we did not find that mother's education was related to vaccine uptake in rural areas, although the small number of mothers in these areas with formal education might explain this. We did find that indicators of better socio-economic status, such as good roof type and having a better job were important determinants of vaccine uptake. The focus groups confirmed the importance of costs (such as travel and time away from work) as obstacles to vaccination for poor families. These costs get higher as the distance to the facility increases, compounding inequity for those who are poorest.

Figures 1 and 2 illustrate the importance of different aspects of equity in determining vaccine uptake in urban and rural areas. In urban areas (Figure 1) better access to vaccination and maternal education seem to increase vaccination uptake by about the same amount, and maternal education compounds with access when it is present. This illustrates how, in urban areas with good access, inequities between households still exist, in this case in terms of maternal education. This is consistent with authors who believe that inequities are not limited only to rural and marginal areas, and can exist within all socio-economic groups [2,36]. It also demonstrates that in urban areas at least, access alone is not the only equity factor involved in uptake of vaccination.

In rural areas, however, (Figure 2) there is a clear advantage for those living in areas with better access. The advantage for better off households (those with a better roof) seems to be confined to areas with poor access to services. It is probable that in areas with poor access the costs of taking a child for vaccination are much higher and therefore the disadvantage of poor households is more apparent. This compounding of inequity results in the very low vaccination rate of only 33% among poor rural households with poor access to services. This supports existing research that shows, while inequity is not *limited* to the most marginalised communities, the equity gap is increasing between the rich and the poor and that the poorest continue to receive the poorest service [1,37,38]. Overall rates of vaccination are lower in rural areas than in urban areas, and even lower still in the most marginalised rural areas.

Measles vaccination coverage is stagnating, or even decreasing, in some parts of Pakistan and this could be related to increasing inequities. Even when overall vaccination coverage in a country is increasing, this may mask considerable and even increasing inequities in coverage, particularly among the most vulnerable households [39]. Measures of vaccination coverage should include an assessment of inequities. The importance of different measures of inequity will vary from place to place, and even within different regions of one district. Understanding the particular dynamics of inequity and how it interacts with other factors related to vaccine uptake is a step towards increasing equity in vaccine coverage.

Conclusions

Inequities of access, maternal education and household socio-economic status are important determinants of childhood measles vaccination uptake in a poor district of Pakistan with limited provision of vaccination services. These inequities compound one another, so children from families with multiple disadvantages are very unlikely to be vaccinated, marginalising them even further with higher risk of poor health.

A hopeful finding is that discussion about vaccines and knowledge about vaccines had a positive effect that was independent of the negative effect of inequity – in both urban and rural areas. At least as a short-term strategy, there seems to be reason to expect an intervention increasing knowledge *and discussion* about vaccination in this district might increase uptake.

List of abbreviations used

WHO – World Health Organization; CIET – Community Information for Empowerment and Transparency; EPI – Expanded Programme on Immunisation; LHW – Lady Health Worker.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

SM contributed to the design, conducted the analysis and drafted the manuscript. NA designed the study, developed the methodology, and contributed to the analysis and the drafting of the manuscript. NMA contributed to the instrument design, supervised the fieldwork and contributed to data analysis. KO coordinated the project in Pakistan and contributed to the drafting of the manuscript. JLS contributed to the design, analysis and drafting of the manuscript. AC contributed to data analysis, was responsible for overseeing the project in Pakistan, and contributed to the drafting of the manuscript.

Acknowledgements

This work was carried out with the aid of a grant from the International Development Research Centre (IDRC), Ottawa, Canada, as part of the Canadian International Immunization Initiative Phase 2 (CIII2). This initiative is a project of the Global Health Research Initiative (GHRI). The views expressed are those of the authors and do not necessarily reflect the views of IDRC. Recognition is also due to the CIET field teams in Lasbela, and the respondents who contributed to the survey.

This article is published as part of *BMC International Health and Human Rights* Volume 9 Supplement 1, 2009: The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants. The full contents of the supplement are available online at http://www.biomedcentral.com/1472-698X/9?issue=S1.

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Evidence-based discussion increases childhood vaccination uptake: a randomised cluster controlled trial of knowledge translation in Pakistan

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from The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants

Published: 14 October 2009

BMC International Health and Human Rights 2009, **9**(Suppl 1):S8 doi:10.1186/1472-698X-9-S1-S8

This article is available from: http://www.biomedcentral.com/1472-698X/9/S1/S8

Abstract

Background: Childhood vaccination rates are low in Lasbela, one of the poorest districts in Pakistan's Balochistan province. This randomised cluster controlled trial tested the effect on uptake of informed discussion of vaccination costs and benefits, without relying on improved health services.

Methods: Following a baseline survey of randomly selected representative census enumeration areas, a computer generated random number sequence assigned 18 intervention and 14 control clusters. The intervention comprised three structured discussions separately with male and female groups in each cluster. The first discussion shared findings about vaccine uptake from the baseline study; the second focussed on the costs and benefits of childhood vaccination; the third focussed on local action plans. Field teams encouraged the group participants to spread the dialogue to households in their communities. Both intervention and control clusters received a district-wide health promotion programme emphasizing household hygiene. Interviewers in the household surveys were blind of intervention status of different clusters. A follow-up survey after one year measured impact of the intervention on uptake of measles and full DPT vaccinations of children aged 12-23 months, as reported by the mother or caregiver.

Results: In the follow-up survey, measles and DPT vaccination uptake among children aged 12-23 months (536 in intervention clusters, 422 in control clusters) was significantly higher in intervention than in control clusters, where uptake fell over the intervention period. Adjusting for baseline differences between intervention and control clusters with generalized estimating equations, the intervention doubled the odds of measles vaccination in the intervention communities (OR 2.20, 95% CI 1.24-3.88). It trebled the odds of full DPT vaccination (OR 3.36, 95% CI 2.03-5.56).

Conclusion: The relatively low cost knowledge translation intervention significantly increased vaccine uptake, without relying on improved services, in a poor district with limited access to services. This could have wide relevance in increasing coverage in developing countries.

Trial registration: ISRCTN12421731.

Background

Childhood vaccination coverage is stagnating and even deteriorating in parts of Africa and South Asia [1]. In Pakistan's Balochistan province, for example, measles vaccination uptake fell from 70% in 2005-6 to 54% in 2006-7; full DPT vaccination uptake fell from 70% to 58% over the same period [2].

The reasons for the declining vaccination rates are uncertain but could include increasing transport costs and possibly decreasing encouragement from government health services to take up vaccination, sometimes even with cutbacks in service provision.

Most initiatives to increase coverage of childhood vaccination in developing countries involve improvement or extension of health services [3,4]. The short-term reality is that the service offer cannot improve without sizeable investment; health services are stretched to maintain their existing service offer, including childhood vaccination. Yet many households do not take up the existing offer of vaccination.

In practice, parents weigh up the cost of vaccinating their children now, against the discounted costs of a possible illness in the future [5-7]. Where household resources are scarce and little public attention is paid to vaccine preventable diseases, the present costs of vaccinating easily eclipse the discounted costs of the possible future disease [8,9]. As a consequence, many children do not receive vaccination.

We could identify only a handful of credible studies reporting knowledge translation interventions that increase vaccination uptake without requiring improvement of the service offer [10].

If non-vaccinating households could access and discuss accurate local information about actual costs and benefits, we hypothesised they might arrive at a cost-benefit equation more favourable to childhood vaccination. This should increase vaccination uptake compared with non-discussion communities even without increased access to services.

A randomised controlled trial tested our hypothesis in Lasbela, one of the poorest districts of Balochistan province in Pakistan. We published the protocol of the trial prior to commencement [11].

Methods

Trial participants

In 2005, we randomly selected 32 enumeration areas (EA) from Lasbela district population census [12]. In each EA, interviewers contacted homes of approximately 100 children under the age of 60 months. The district population is scattered, and each EA comprised four or five villages. After the baseline study [13], a random number generator allocated the baseline communities to 18 intervention and 14 control EAs. The sequence was concealed and the intervention assigned centrally. The intervention group was thus 18 enumeration areas, each of four or five villages and including a total of 3166 children under the age of five years. The 14 control EA, also each of four or five villages, included a total of 2475 children.

The intervention

In preparation for the intervention the team synthesised the international literature on the likely impact of measles vaccine. Using the baseline study of this trial, it was also possible to estimate the cost and the benefit of recent vaccination in Lasbela district. In the event, measles vaccination in the district proved to have low efficacy [14].

We consulted non-sample communities about how best to present and discuss the evidence from the baseline survey within communities, so that as many households as possible would be drawn into discussing the evidence and perhaps making a positive decision to vaccinate their children as a result. The focus group discussions in these communities indicated clearly that belief in the efficacy of

the vaccine was simply not the problem; the overwhelming concern was about the costs of having children vaccinated. Consequently the intervention relied more on the costs of treating measles cases and of having children vaccinated (including travel costs, actual treatment costs but excluding time costs). It cost many times more to treat a child with measles than it did to vaccinate a child against measles (in a ratio of 33:1). Some families, however, paid much less for cases of measles they treated at home (as was the accepted traditional practice in some of the communities). Informed by the discussions in non-sample communities, we developed detailed guides for conducting discussions with community members, to take place in three phases, each phase sometimes requiring several meetings to allow the participants to come to a conclusion from the evidence-based discussion.

We recruited and trained men and women from Lasbela to lead and record the three-phased discussions in the intervention communities. Training for each phase of the intervention lasted two to three days, including classroom sessions and field practice. We trained more people than required for the intervention and selected those who performed best to undertake the work, forming nine field teams, each with male and female members. The field teams completed the discussions in the 18 intervention communities between August 2006 and March 2007. The population of Lasbela is scattered and each community had several villages. The teams organised male and female groups in the 94 villages; a total of 180 community groups, each of 8-10 people, participated in the intervention. The activities of the field teams included: meeting community leaders to explain the purpose of the intervention and seek permission to work in the community; identifying suitable members for the discussion groups; scheduling and facilitating the three phases of discussion (sometimes requiring several meetings for a phase); and assisting the groups to list local barriers to vaccination and develop action plans. The people selected to take part on the discussion groups were trusted within their community and able to convince others about important issues. Generally the same people participated in all the discussion sessions; sometimes additional participants joined after the initial session and a few people were not able to continue through all the sessions.

In the *first phase* the community groups analysed the situation about child vaccination in their union council (the smallest administrative unit within the local government system, and for which we had disaggregated information from the baseline survey). They discussed the prevalence of measles among children and the proportion of children getting vaccinated in their own community, and the importance of childhood vaccinations. The facilitators shared the district level evidence that a child who is not vaccinated has twice the risk of measles, compared with a child who is vaccinated.

The *second phase* discussed evidence on costs and benefits of vaccination from the baseline survey, including the costs of treating a child with measles in comparison with the costs of getting a child vaccinated against measles. The groups also discussed the complications of measles, and benefits and adverse effects of measles vaccination.

In the *third phase* the groups identified the specific challenges and barriers to child vaccination in their own communities and developed plans for actions they could take themselves to address some of these challenges. These included methods for spreading the discussion about vaccination to other community members, as well as ways to increase access to vaccination services, such as sharing transport and helping with childcare. Although the facilitators discussed with participants their plans for disseminating the discussions within their communities, the intervention did not make special provision for the participants to "take back" the discussion to others in the community, relying rather on endogenous networks for the information spill over.

Local supervisors supported and monitored the work of the field teams and documented the outcome of the three phase discussions, using structured checklists and reporting formats. They visited the teams in the field, provided feedback, and assisted them to remedy any problems encountered with the intervention implementation.

During the period of the intervention, the Lasbela government health department implemented a health education programme in the district, aiming to reach all communities, with messages particularly about household hygiene and prevention of diarrhoea in children. Both intervention and control communities received this health education programme, implemented mainly through lady health workers (LHW) and other local officers, who received specific training for this activity.

Outcomes

The primary outcome was uptake of measles and full DPT vaccination of 12-23 month olds, as reported by the main caregiver. We used well-known local terms for the various vaccinations, and described their timing and administration (for example, "an injection into the upper arm" for measles vaccine) to assist mothers' recall; we did not verify the mothers' reports by checking vaccination cards among those who held these. Secondary outcomes specified per protocol were the theory-based "cascada" of intermediate outcomes leading to vaccination uptake: conscious knowledge, attitudes about vaccination, subjective norms, intention to change, agency/self efficacy, and

Table 1 - Baseline characteristics of intervention and control children aged 12-23 months, with significance tested using a cluster comparison (based on numbers of children in order to assess baseline differences in intervention and control groups).

	Intervention		Control		Cluster analysis (t-test)	Naïve 2x2 Mantel Haenszel odds ratio
	%	Based on	%	Based on		
Households:						95%CI
Roof type (good)	36%	202/533	28%	125/371	P=0.451	0.90–1.61
Breadwinner income (good)	50%	263/529	55%	203/367	P=0.287	0.60–1.05
Low room occupancy	40%	217/532	46%	174/371	p=0.213	0.59–1.03
Household not vulnerable	36%	195/528	40%	158/367	P=0.635	0.58–1.03
Head of HH has formal education	35%	198/531	33%	135/371	P=0.693	0.78–1.39
Vaccination facility within 5 km	55%	308/487	30%	152/364	p=0.127	1.81–3.22
Village visited by vaccination team	43%	227/491	31%	86/323	P=0.398	1.74–3.29
Mothers:						
Willing to travel to vaccinate	98%	420/431	89%	278/309	P=0.009	3.64–98.3
Mother has formal education	8%	48/538	6%	28/373	P=0.511	0.73–2.11
Have heard about vaccinations	89%	490/537	86%	328/373	P=0.511	0.90–2.27
Know a vaccine preventable illness	84%	458/534	73%	274/365	P=0.084	1.41–2.87
Neighbours think vaccination worthwhile	86%	471/537	79%	301/368	P=0.310	0.96–2.35
Think vaccination worthwhile	94%	512/537	90%	335/366	P=0.228	0.99–3.51
Ever visited by LHW	32%	198/538	12%	50/373	P=0.068	2.68–5.56
LHW told about vaccinations	9%	59/533	5%	21/372	P=0.445	1.26–3.94
Children (12-23 months):						
Measles vaccination	47%	279/537	49%	198/367	P=0.832	0.70–1.22
DPT-full schedule	51%	304/536	45%	184/366	P=0.505	0.98–1.71
Polio vaccine in last 12m	99%	530/537	100%	369/369	P=0.502	–

discussion within the household [11]. In the baseline (spring 2005) and follow-up (spring 2007) surveys, a household questionnaire included questions about vulnerability of the household and questions to mothers concerning their education, childcare knowledge, attitudes and practices.

The field coordinator for the household surveys (MB) knew which clusters had received the intervention but interviewers did not. We did not evaluate the success of this blinding. Only a few people participated in the structured discussion groups but the intention was for these people to widen the discussion, so that most parents in each intervention cluster would know of the structured discussions.

Analysis

Cluster was the unit of randomisation, intervention and principal analysis. All analyses followed the intention to treat principle, considering all children in designated intervention clusters as exposed irrespective of parental participation in the structured discussions. For the principal analysis of primary outcomes we used an unpaired t-test of vaccination rates children aged 12-23 months in intervention clusters compared with control clusters. We estimated absolute event rates in intervention and control groups, number needed to treat (NNT) and its 95% confidence interval.

An earlier analysis of the baseline survey showed the importance of several factors in the vaccination of children in Lasbela [13]. To adjust for significant baseline differences (see Table 1), we used generalized estimating equation (GEE) in the R package Zelig [15]. Because several factors converged around the distance from facility (including visits from vaccination teams, visits of LHWs and, consequently, information provided by the LHW), we combined distance (less than 5 km) and visit by a LHW in a single variable representing access. Adjusting for the baseline differences – willingness to travel and knowledge of a preventable disease – in an exchangeable correlation structure (logit.gee model, 1000 simulations). Analysis of secondary outcomes followed the same principles.

We used Amelia II [16] to impute values for missing data with an EM algorithm for all variables included in the GEE model of the primary outcomes. Estimates reconciled data from ten imputed data sets using Rubin's approach [17] in the R package Zelig [18].

Ethical review

A registered ethical review board in Karachi, Pakistan, approved the study in 2004. A separate ethical review board at the University of Ottawa approved it in 2005.

Results

The baseline survey contacted 538 children aged 12-23 months in intervention and 373 in control communities. The follow-up survey contacted 536 in intervention and 420 in control communities, the increase in the control communities being because of fuller access to one of the

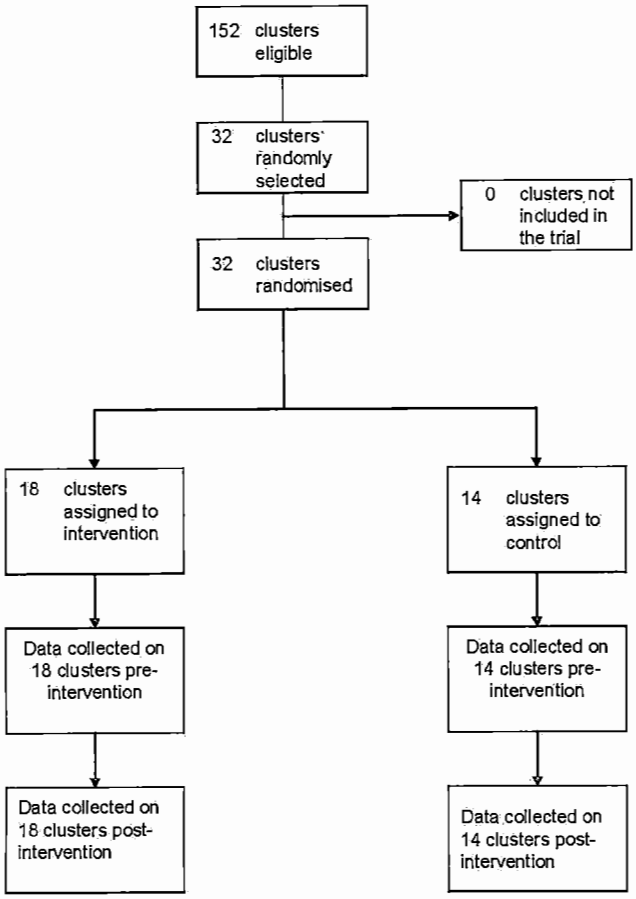

Figure 1 - Consort diagram of clusters and flow through the trial.

control communities, which was not possible in the baseline survey.

Figure 1 shows the flow of clusters through each stage. There were no deviations from protocol. Table 1 shows the baseline difference between intervention and control groups: knowledge of vaccine protection, visits by LHWs (who visit homes recommending child care activities) and access (less than 5 km from a vaccination post).

Table 2 shows the cluster analysis for measles vaccination (12-23 months of age). Intervention clusters had significantly higher vaccination rates (50% compared with 30%, RD 0.20, 95% CI 0.031-0.372). A similar size difference was evident for full DPT (51.7% compared with 23.2%, RD 0.285, 95%CI 0.141-0.429, Table 3). We detected no meaningful difference in the already high rates of polio vaccination (intervention mean 0.988 based on 524/530, control mean 0.986 based on 415/422; RD 0.002 95%CI −0.0014-0.017).

Table 2 - Proportion of children (12-23 months) reported to have received measles vaccine.

	Intervention clusters			Control clusters	
1	15/26	0.58	1	26/33	0.79
2	17/24	0.71	2	20/37	0.54
3	25/31	0.81	3	16/35	0.46
4	29/38	0.76	4	11/21	0.52
5	9/26	0.35	5	2/19	0.11
6	34/55	0.62	6	1/28	0.04
7	12/16	0.75	7	10/25	0.40
8	25/44	0.57	8	21/33	0.64
9	29/43	0.67	9	10/37	0.27
10	5/21	0.24	10	0/20	0
11	16/26	0.62	11	1/16	0.062
12	13/19	0.68	12	3/39	0.077
13	0/20	0	13	10/36	0.28
14	16/34	0.47	14	5/41	0.12
15	7/30	0.23			
16	8/36	0.22			
17	16/26	0.44			
18	7/21	0.33			
	283/536	mean 0.50		136/420	0.30

Pooled SD 0.234, Difference 0.20, 95% 0.031-0.372 t=2.413, 30df p=0.0221. NNT=5, 95%CI 3-31.

Table 3 - Proportion of children (12-23 months) reported to have received full course of DPT (diphtheria, pertussis, tetanus) vaccine.

	Intervention clusters			Control clusters	
1	14/26	0.54	1	19/33	0.58
2	20/24	0.83	2	15/37	0.41
3	17/30	0.56	3	14/35	0.4
4	27/38	0.71	4	10/22	0.45
5	6/26	0.23	5	1/19	0.05
6	29/55	0.53	6	1/28	0.04
7	9/16	0.56	7	9/25	0.36
8	24/44	0.54	8	6/33	0.18
9	30/43	0.70	9	10/36	0.28
10	6/21	0.29	10	0/20	0
11	17/26	0.65	11	1/18	0.056
12	15/19	0.79	12	4/39	0.10
13	1/20	0.05	13	8/36	0.22
14	19/34	0.56	14	5/42	0.12
15	13/30	0.43			
16	11/37	0.30			
17	18/26	0.69			
18	7/20	0.35			
	283/535	0.517		103/422	0.232

Difference 0.285 95%CI 0.141-0.429 t=4.06 30df p=0.0003. NNT3.5, 95%CI 2-7.

Adjusting for baseline differences using a logit model generalised estimating equation, the intervention effect remained high (first difference 0.19, 95% CI 0.05-0.32). This represents doubling of the odds of measles vaccination in the intervention communities (OR 2.20, 95% CI 1.24-3.88). Adjusting the effect on DPT3 vaccination by the baseline differences, the first difference dropped slightly

Table 4 - Cluster analysis of secondary outcomes (cascada) among parents of children aged 9-60 months (t-test of difference between 18 intervention and 14 control sites, cluster analysis as in Tables 2 and 3).

	Intervention clusters	Control clusters	Outcome in primary (cluster) analysis (t-test)	GEE adjusting for baseline differences
Respondent could mention an illness preventable by vaccination (conscious knowledge)	2368/3153 mean 0.74	1437/2431 mean 0.58	Difference 0.17, 95% 0.067–0.272 t=3.369, 30df p=0.002	Difference 0.121 95% 0.055–0.189 (1)
Do you think it's worthwhile to vaccinate children? (attitude)	3006/3161 mean 0.95	2116/2475 mean 0.84	Difference 0.11, 95% 0.021–0.197 t=2.543, 30df p=0.016	Difference 0.054 95% 0.013–0.105 (1)
Do your neighbours think it's worthwhile to vaccinate children? (subjective norm)	2842/3166 mean 0.89	1884/2475 mean 0.74	Difference 0.15, 95% 0.039–0.260 t=2.755, 30df p=0.010	Difference 0.095 95% 0.011–0.182 (1)
How much time are you prepared to spend to take a child from your household to be vaccinated? Willing to take some time (intention)	2954/3088 mean 0.95	2037/2317 mean 0.84	Difference 0.11, 95% 0.002–0.227 t=2.086, 30df p=0.046	Difference 0.073 95% 0.015–0.156 (2)
Mother included in decisions about vaccination (agency)	1834/3131 mean 0.59	1345/2434 mean 0.54	Difference 0.04, 95% –0.024–0.108 t=1.299, 30df p=0.204	Difference 0.043 95% –0.009–0.097 (NS) (3)
Have you discussed vaccination for children in the family? (discussion)	1584/3155 mean 0.49	826/2459 mean 0.31	Difference 0.19, 95% 0.054–0.318 t=2.868, 30df p=0.007	Difference 0.155 95% 0.032–0.270 (2)

Initial model: intervention, willingness to travel, access, knowledge of preventable disease.
(1) Final model: intervention, willingness to travel, access.
(2) Final model: intervention, knowledge of preventable disease.
(3) Final model: intervention, knowledge of preventable disease, access.

from 28.5% to 27.0% (95% CI 0.162-0.38). This corresponds to three-fold odds of completing DPT vaccination among the intervention group compared with the controls (OR 3.36, 95% CI 2.03-5.56), after adjusting for baseline differences.

To test the effect of missing data on the primary outcomes, we remodelled the GEE estimates across 10 data sets with missing values imputed from other variables. The impact of measles vaccination remained constant (RD 0.1864, 95% 0.0417- 0.3311), as did that for full DPT vaccination (RD 0.2674, 95% 0.1449 - 0.3746). The initial models included willingness to travel, knowledge of a vaccine preventable illness and access (a composite variable combining distance less than 5 km and visit by a LHW). The final models for both included only the intervention and access.

The analysis of secondary outcomes, per protocol, dealt with each of a "cascada" of precursors to vaccination uptake [11,19]. Table 4 shows a significant impact on conscious knowledge and attitudes about vaccination, subjective norms, intention to change, and discussion in the home. These results are summarised in Figure 2. The GEE analysis of secondary outcomes, adjusting for the same baseline differences, confirmed these findings.

Discussion

The results support the hypothesis that evidence-based structured community discussions can increase vaccine uptake without relying on improvements of health service delivery. In a context of falling vaccination coverage, the intervention maintained rates at the baseline level. Compared with control communities, this doubled the odds of 12-23 month old children receiving measles vaccination and tripled the odds of completing DPT vaccination. It will be important to examine the impact of the intervention where vaccination uptake is not falling.

We adjusted the findings of the conservative cluster analysis by baseline differences. We did not control for covariants in the follow-up survey, as these could constitute part of the causal chain. For example, adjusting for whether households "had discussed vaccination in the household" would reduce the measured intervention effect; under the hypothesis, vaccination uptake is a consequence of discussions in the household, which is, in turn, a consequence of the structured community discussions.

In the Lasbela context, where very few families have up to date health records, we had to rely on the caregiver's report of vaccination uptake. Authors from developed countries

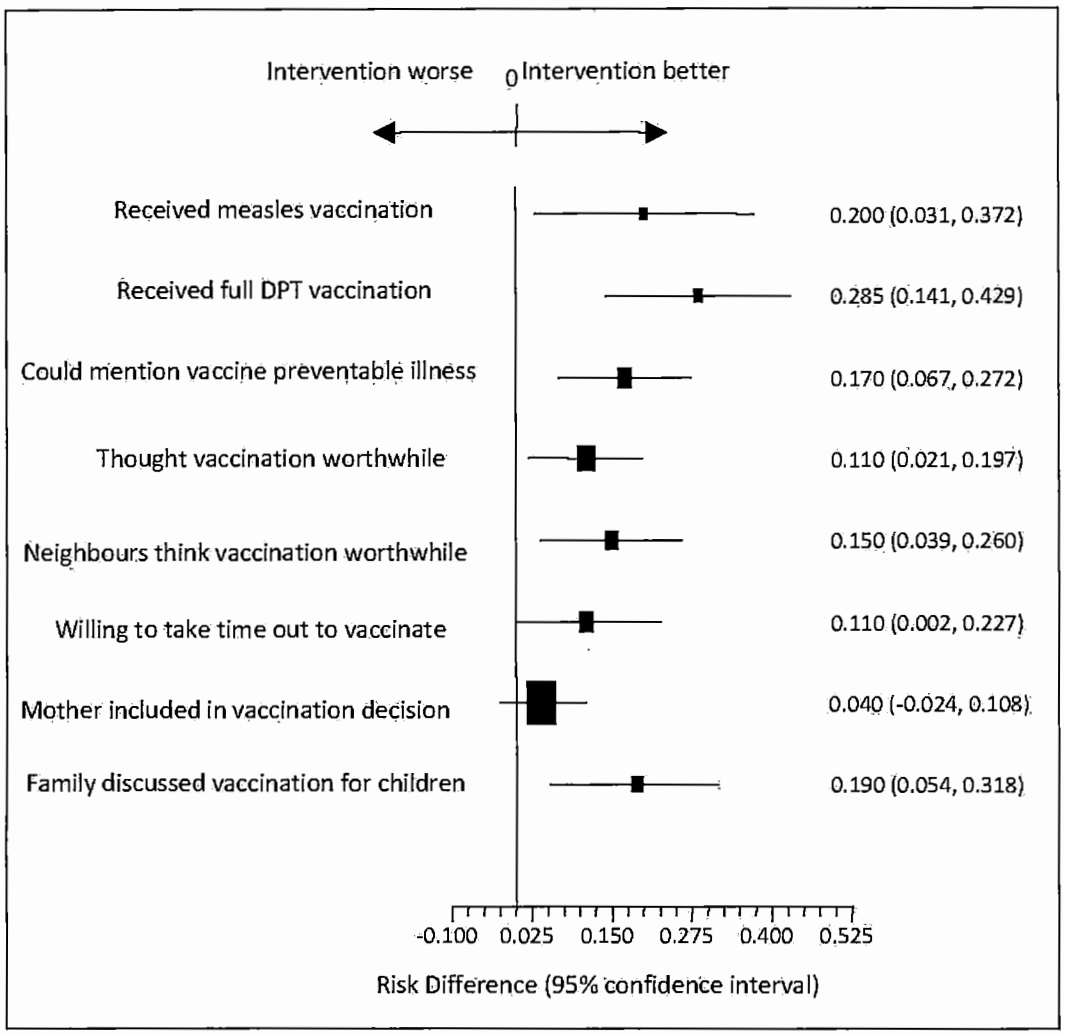

Figure 2 - Secondary impacts of the intervention.

have argued that maternal recall is inadequate compared with health facility records [20,21]. Studies from developing countries contrast this, concluding that reliance on mothers' reports gave accurate estimates of coverage in Egypt [22], Sudan [23], Guatemala [24] and Costa Rica [25]. A study in India found that maternal recall underestimated children's vaccination status but using vaccination cards was not helpful because less than half the mothers had cards and the cards were often incomplete or grossly inaccurate [26].

Even if maternal recall is adequate for estimating coverage, it is theoretically possible that those exposed to the intervention overstated uptake – a halo effect. However, we consider this unlikely. First, the intervention only directly involved a few participants, and the further spread of discussion came from within the community. At about the same time, both intervention and control communities received visits promoting child and household hygiene. Second, the communities continue to request that the mobile polio vaccination teams should also offer measles vaccine; overstating uptake does not fit with this. Both intervention and control groups already had very positive views of vaccination in the baseline studies (Table 1).

Knowledge translation has increased reported vaccination uptake in other settings, although often with some accompanying changes to service delivery. In Ghana, home visits to engage people in discussions about vaccination increased uptake in towns with relatively low coverage rates [27]. A similar door-to-door approach claimed a positive impact in Mozambique [28]. "Village-resource rooms" were successful in improving knowledge in the West Bank, although they did not increase vaccination

uptake [29]. In the Philippines, a mass media campaign claimed to increase vaccine uptake by 11% [30]. And in Bangladesh, advocacy among women by a credit programme increased measles vaccine uptake by 9% [31].

We viewed the secondary outcomes as precursors of vaccination uptake. The convincing impact of the intervention on these offers useful supportive evidence for a causal linkage between the intervention and vaccine uptake. The single exception was the variable used to measure self-efficacy or agency to take up vaccination, inclusion of the mother in decisions about childhood vaccination. This could reflect a local lack of influence of women in decisions relating to the health of their children; or it could reflect the weakness of our indicator of agency.

Apart from this, the fact that the intervention significantly changed all steps in the *cascada* (Figure 2) is compatible with the intervention changing behaviour in a reasoned way: conscious knowledge increased, attitudes towards vaccination improved, subjective norms improved as did intention to vaccinate and discussion of the value of vaccination.

The structured discussion rounds sometimes led to action plans in the intervention communities beyond stimulating discussion about vaccinations within households. Particularly in those villages with poor access to vaccination services, plans included sharing transport to vaccination points and providing care for some children while parents took others to be vaccinated. These community initiatives may have helped to maintain vaccination levels in the face of generally falling levels.

We estimated the direct costs of implementation of the intervention within Lasbela, with six field teams undertaking the three phased discussions in 18 communities (94 villages), with a total of 180 community groups. Including direct field supervision but excluding the costs of provincial and national coordinators working on the project, the intervention cost US$63,600. This does not include the costs of the baseline and follow up surveys. Based on our experience with supporting a district government health education programme in the district, the district government could implement the knowledge translation intervention throughout Lasbela district – where there are around 10,000 children in the 12-23 month age group – for the equivalent of US$90,000 ($9 per child vaccinated in the target age group).

Conclusions

New vaccines, the investment emphasis of the global vaccine initiative, are unlikely to reach children not already receiving existing vaccines. Implementation research is urgently needed to inform strategies to increase vaccine uptake, especially in those parts of the world where vaccination coverage is low or even decreasing. We would not expect the exact intervention applied here, based on specific results of the baseline study, to be applicable elsewhere, but the approach might be so.

We involved only a few participants directly in the evidence-based discussions about costs and benefits but, not a trivial finding, the impact was measurable beyond that. It is possible that involving greater numbers of people in structured discussions directly in each community could increase the vaccination uptake further. Action plans developed in some communities suggest the intervention may also improve the terms of engagement between communities and service providers.

The household cost-benefit equation is a lens for understanding and negotiating parental decisions about vaccination: people weigh things up before making their health choices. This household equation for childhood vaccination can also be modified by appropriate knowledge translation without relying on improved services. In the Lasbela case, the pre-intervention household cost-benefit equation might well have taken into account the low efficacy, and the household opted not to invest in it. The trial set out to show an increase in the *demand side* of uptake, and we believe we achieved that. The remaining uncomfortable truth is that even if this is possible, it is often still important to increase the efficacy through improved service delivery quality. Future research should focus on both demand and supply side interventions, alone and in combination.

List of abbreviations used

EA – Enumeration area; NNT – Number needed to treat; GEE – Generalized estimating equation; LHW – Lady health worker.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

NA designed the study, undertook the analysis and drafted the report. AC assisted with the design and analysis, supported the surveys and intervention, and helped to draft the report. KO was responsible for the surveys and for data management, and reviewed the report.NMA helped manage the surveys, led the intervention and reviewed the report. MB coordinated the field teams for the surveys and intervention and reviewed the report. AHF reviewed the design, assisted with the analysis and reviewed the report. BS reviewed the design, advised on the analysis and reporting. GAW reviewed the design, advised on the analysis and reporting. JLS reviewed the design, advised on the analysis and reporting.

Acknowledgements

This work was carried out with the aid of a grant from the International Development Research Centre (IDRC), Ottawa, Canada, as part of the Canadian International Immunization Initiative Phase 2 (CIII2). This initiative is a project of the Global Health Research Initiative (GHRI).

This article is published as part of *BMC International Health and Human Rights* Volume 9 Supplement 1, 2009: The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants. The full contents of the supplement are available online at http://www.biomedcentral.com/1472-698X/9?issue=S1.

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BMC International Health and Human Rights

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Portrait of a lengthy vaccination trajectory in Burkina Faso: from cultural acceptance of vaccines to actual immunization

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from The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants

Published: 14 October 2009

BMC International Health and Human Rights 2009, **9**(Suppl 1):S9 doi:10.1186/1472-698X-9-S1-S9

This article is available from: http://www.biomedcentral.com/1472-698X/9/S1/S9

Abstract

Background: The global recognition of vaccination is strongly related to the fact that it has proved in the past able to dramatically reduce the incidence of certain diseases. Nevertheless, reactions regarding the practice of vaccination still vary among communities, affecting the worldwide vaccination coverage. Numerous studies, conducted from varying perspectives, have focused on explaining this active refusal or resistance to vaccination. Although in some cases low immunization coverage has been well explained by active refusal or resistance to vaccination, little is known about the reasons for low coverage where those reactions are absent or play a minor role, especially outside an epidemic context. This study attempts to explain this situation, which is found in the health district of Nouna in Burkina Faso.

Methods: An in-depth ethnographic study was undertaken in the health district of Nouna in an effort to understand, from an anthropological point of view, the logic behind the parental decision-making process regarding the vaccination or non-vaccination of children, in a context where rejection of, and reservations concerning vaccination are not major obstacles.

Results: Three elements emerged from the analysis: the empirical conceptions of childhood diseases, the perceived efficacy of vaccine and the knowledge of appropriate age for vaccination uptake; the gap between the decision-making process and the actual achievement of vaccination; and the vaccination procedure leading to vaccination uptake in the particular context of the health district of Nouna.

Conclusions: The procedures parents must follow in order to obtain vaccination for their children appear complex and constraining, and on certain points discord with the traditional systems of meaning and idioms of distress related to pregnancy, the prevention of childhood diseases and with the cultural matrix shaping decision-making and behaviour. Attention needs to be directed at certain promotional, logistical and structural elements, and at the procedure that must currently be followed to obtain vaccination for a child during routine vaccination sessions, which are currently limiting the active demand for vaccination.

Abstract in French: See the full article online for a translation of this abstract in French.

Abstract in French

See Additional file 1 for a translation of the abstract to this article in French.

Background

The global recognition of vaccination is strongly related to the fact that it has proved capable of dramatically reducing the incidence of certain diseases [1-5]. Among many examples are the worldwide eradication of smallpox and of poliomyelitis throughout the West. Vaccination has also led to a drastic reduction of children infected with measles, diphtheria, tetanus and whooping cough [1]. Moreover, vaccines represent a promising avenue in the battles against malaria, Influenza A (subtype H5N1) and the HIV virus [1,6].

Nevertheless, reactions regarding the practice of vaccination still vary among communities, affecting the worldwide vaccination coverage. Nichter [7] and Streefland [8,9] distinguished four basic types of community reactions to vaccination, running in a continuum from refusal to demand: "active refusal or refusal," "passive refusal or resistance," "passive acceptance" and "active demand".

Numerous studies, conducted from varying perspectives, have focused on explaining this active refusal or resistance to vaccination. The social sciences and especially anthropology have raised the question of the biopower, or biopolitics, associated with vaccination in order to explain its rejection [8,10]. Some groups are opposed to vaccination on ethical grounds, claiming that mandatory vaccination represents government interference in what they consider to be a matter of entirely personal choice [11,12]. In the same category are positions citing philosophical or religious beliefs [11] that may limit the introduction of foreign substances into the body [8,10,13-15], or the idea that sickness can only be prevented by an action related to a divinity, an ancestor or some other spiritual entity [13,16,17].

Other studies have been based on psychological behavioural models, using certain elements of the health belief model [18,19] to explain a non-support of vaccination. According to these models, some individuals may be convinced that they run little risk of contracting the diseases targeted by vaccination, or that vaccination represents a greater threat to their health than the diseases themselves [1,11,20]. This reluctance or fear may also be the result of a lack of information concerning the actual effect on the body or the potential side effects in the short, medium and long-term [10,21-23]. Conversely, it may be caused by the bulk of available information, sometimes contradictory, particularly since the advent of domestic access to the Internet, where views for and against vaccination can impede the decision-making process [1,13,21,24].

In African settings more specifically, active refusal has been seen as the result of fear campaigns attempting to undermine national health initiatives, sometimes for a partisan purpose, or alternatively under the influence of religious or moral African leaders who, again, see vaccination as contravening their fundamental doctrinal principles [8,10,11,13-15]. Very often these groups believe, or encourage the population to believe, that vaccination activities are a cover for a form of birth control by contraceptive injection, that the AIDS virus can be transmitted via the vaccination procedure, or simply that it is forbidden by their beliefs. Other studies evoked the organisational problems of the Expanded Program on Immunization (EPI) and its poor health care quality, including overestimated cost of vaccination records, incoherence in the follow-up of vaccination and disruption in the cold chain [25]. Passive refusal, according to the results of available studies in African settings, occurs on a more individual basis, each person having their own reasons for refusing vaccination, including fear of side effects, insufficient time to attend vaccination sessions or simply lack of motivation [7-9].

In Burkina Faso, campaigns designed to raise awareness about the importance of vaccination seem to have had positive results regarding the acceptance level of vaccination, notably during the last vaccination campaign against the meningitis epidemic of 2002. According to the report produced by the World Health Organisation/European Commission's Humanitarian aid Office (WHO/ECHO), all modern and traditional means of communication were used to encourage communities to

accept vaccination, and the population responded very positively. In Ouahigouya, a city located in the north of Burkina Faso, the city's only private radio station was mobilized for the occasion. Messages were broadcast in French and Moré, reminding citizens of the importance of vaccination and giving information about the places and dates of upcoming vaccination sessions. The awareness campaign received additional support from traditional chiefs and religious leaders, and the promotion was a success, resulting in major participation in the vaccination program in that epidemic context [26].

Although low immunization coverage has been well explained by active refusal or resistance to vaccination, little is known about the reasons for low coverage, especially outside an epidemic context, where those reactions are absent or play a minor role. The question now is: how can one explain the low rates of vaccination attendance outside of epidemic contexts in parts of the world where general levels of opposition to the practice are quite low, where one find mostly passive acceptance or demand and where the various obstacles inducing active or passive refusal are almost absent? This study attempts to explain this situation, which is found in the health district of Nouna in Burkina Faso.

Methods

In order to answer this question, an in-depth ethnographic study was undertaken in the health district of Nouna as part of the ETUVAC (ETUde sur la VACcination) strategy aiming at improving immunization coverage among children aged 0 to 11 months old. It was performed in an effort to understand, from an anthropological point of view, the logic behind the parental decision-making process regarding the vaccination or non-vaccination of children, in a context where rejection of, and reservations concerning vaccination are not major obstacles.

The health district of Nouna is situated in the northwest of Burkina Faso, around 300 km from the capital of Ouagadougou. This region is inhabited by five principal ethnic groups (Marka, Bwaba, Samo, Mossi and Peulh). The population, close to two-thirds of whom are illiterate, is essentially rural and agricultural, with subsistence agriculture predominating. There are 27 peripheral health posts (Centres de Santé et de Promotion Sociale - CSPS) in the health district of Nouna that cover a population of about 300,000 inhabitants. The health professionals of the CSPS are assisted in their tasks by Village Health Officers (VHOs), who are voluntary workers chosen in each village to transmit information about upcoming immunization sessions between the CSPS and their own village.

Regarding the vaccination coverage of the health district of Nouna, the administrative data derived from the vaccination registers of various CSPS have established the effective vaccination coverage of children from 0 to 11 months in 2002, prior to the ETUVAC strategy. It revealed that only 84% of this cohort received the Bacillus Calmette-Guerin vaccine (BCG -tuberculosis), 54% received the third dose of Diphtheria-Tetanus-Pertussis vaccine (DTP3), 57% received the Measles Vaccine (MV) and 51% received the Anti-Amaril Vaccine (AAV-yellow fever). It was, at that time, well below the national objectives outlined by the WHO and the EPI, which are set at 91% for BCG and 80% for AAV, MV and DTP3 vaccines [27].

The conceptual framework underlying this study in medical anthropology is built around three key concepts: systems of meaning, idioms of distress and cultural matrices. The "Systems of meaning" focuses on the meanings of illness, prevention, as well as the forces that govern access to, and demand for, prevention through vaccination [28]. "Idioms of distress" refer to the suffering experienced by parents as the result of childhood diseases and deaths. These narratives of suffering attempt to circumscribe the uncertainty generated by the possibility of seeing a disease become serious and by the difficulties of effectively treating it or preventing it. These idioms are also present in the discussions surrounding the advantages and inconveniences of having children vaccinated. "Cultural matrices" encompass the moral premises, collective values and beliefs that shape systems of meaning and idioms of distress. Parental behaviour (reluctance, refusal, acceptance) regarding vaccination can be understood in terms of the cultural matrix on which the parents depend to give meaning to the events of their daily lives. It is important to note, however, that the emphasis placed here on the realm of meaning in no way implies that the concrete behaviour of parents is unaffected by the conditions (material, social, political) that impact day after day on the lives of often illiterate families whose priority is the struggle for survival in particularly difficult economic circumstances [29].

In order to collect the data on those subjects, focus groups were performed to gather general data among several categories of individuals taking into account ethnicity, gender and parental experience. General data concerning health, disease, and immunisation was collected with the participation of individuals issued from four ethnic groups: the Marka, Bwaba, Mossi and Peulh. The participants were selected from among four average size villages in the health district of Nouna: Solimana (a Marka village), Kemena (a Bwaba village), Dennissa-Mossi (a Mossi village) and Tebere (a Peulh village). The populations of these villages range from 544 inhabitants (Tebere) to 2,052 inhabitants (Kemena), and they are all situated between 5 and 10 km from the nearest CSPS. Sixteen focus groups (four groups in each one of the four

villages) composed of three people, were performed. In each village (ethnic group), the four focus group were composed of either 1- three primiparous mothers, 2 - three multiparous mothers (three or more children), 3 - three grandmothers or 4 - three fathers (or grandfathers). The different participants were not necessarily related.

After the focus groups, semi-moderated interviews were performed with eight families, which included eight heads of households and their respective wives (and co-wives when applicable). Issues raised at the focus groups by the other participants were discussed in greater depth. In order to understand the factors influencing vaccination uptakes, these semi-moderated meetings were held with two different categories of families: 1 - Four families in which all the children had been adequately vaccinated, and 2 - Four families in which the children's vaccination records showed numerous gaps. Each of these families was chosen among the same four villages and ethnic groups, but with different participants than for the focus groups, for a total of eight independently interviewed families: two Marka families, two Bwaba families, two Mossi families and two Peulh families.

The data were collected with the assistance of four professional translators specially trained by Nouna's health research center (Centre de recherche en santé de Nouna - CRSN) to lead the semi-moderated interviews according to a preset interview scheme and to moderate focus group discussions in the local dialect. Each one was chosen for their experience and linguistic knowledge related to one of the four communities. Simultaneous translation was chosen to ease the interaction between the main investigators, who did not master all the dialects, and the participants. The data was written down on paper for further analysis. The traditional semiology and nosology issues related to diseases were taken into account and discussed with the translators prior to the interviews and focus groups. The closest biomedical translation was then used to ease the analysis. For instance, a fever is usually called "hot body" by the participants, convulsions are called "bird disease" and malaria is called "cool/humidity disease". These biomedical translations are commonly used by researchers and generally accepted for the purpose of the different studies performed in the district.

As a first step, the acceptability of the vaccines was discussed with the participants. They were then questioned on their conceptualisation of the "normal" development of a child to understand how their systems of cultural representations influence their views concerning the onset of various diseases. The goal was therefore the discovery of which diseases, or which symptoms perceived by the community as diseases, are placed in the category of "normal" or inevitable childhood diseases, in other words, the diseases that all children contract at least once during their childhood and that are more or less unavoidable. The participants were also asked which among these diseases, or among other diseases not necessarily considered normal, did they perceive as belonging to the category of diseases that could cause a child's death – fatal diseases, some of which can or should be prevented by a prophylactic treatment such as vaccination, enhancing the demand for vaccination. They finally were asked to talk about the adverse effects that they knew vaccines to cause. Parental knowledge regarding the target age categories of children by the EPI was also discerned. The cultural matrix determining the role of the father, the mother and the grandparents in the decision-making process concerning vaccination, and about the gap between these determinants and actual behaviours, as reflected in the presence or absence of the mother at advertised vaccination sessions, was also discussed. Finally, the trajectory that must be taken, the different steps needed in order to be able to have their child vaccinated, and the burden that this can imply, were investigated.

Results

The acceptance of vaccination

The reaction encountered among the communities questioned about vaccination was general acceptance. During the meetings with the communities, all the interviewed individuals knew about the regular vaccination programs and the periodical visits to their villages by medical staff for the purposes of vaccinating the children, and all said to be in favour of vaccination, i.e. they all wish to obtain the various offered vaccines, either for themselves or for their children:

> "Vaccination is a good thing to prevent disease, even for elderly people. It's well thought of [here in the village], especially since everyone in the village was vaccinated against an epidemic in the 1970s." *Marka father*

One after the other, in every village, each participant clearly expressed his/her acceptance of vaccination. There even seemed to be a certain community demand for it as a preventive method, particularly in the case of an epidemic, as expressed by the remarks of the Marka father just quoted, who proudly showed his vaccination scar and encouraged others to show theirs as proof of what he was saying.

In what follows will be presented three elements that emerged from the analysis that might help to explain why, in a context of acceptance of, and demand for vaccination, rather than rejection, is encountered such a low rate of vaccination coverage. These are: the empirical conceptions of childhood diseases, the perceived efficacy of

Table 1 - Frequency of mentioned diseases/symptoms

Disease/symptoms	Considered Normal/inevitable (n)	Considered potentially fatal (n)	Considered as side effects (n)
Fever	10	5	8
Diarrhea	9	5	3
Stomach/head pains	6	3	1
Cough	8	4	–
Malaria	6	1	–
Chickenpox	4	8	–
Convulsions	3	8	–
Vomiting	3	3	–
Meningitis	–	3	–

Frequency table of the mentioned diseases/symptoms. 1: considered normal/inevitable; 2: considered potentially fatal; 3:considered as possible side effects, by the participant of the focus groups (n = total of participants who mentioned the disease/symptom).

vaccine and the knowledge of appropriate age for vaccination uptake; the gap between the decision-making process and the actual achievement of vaccination; and the vaccination procedure leading to vaccination uptake in the particular context of the health district of Nouna.

Childhood diseases

The diseases (or symptoms considered as diseases) most frequently mentioned by the participants were all considered to be both normal/inevitable and potentially fatal. They are, in frequency order: fever, diarrhoea, chickenpox, cough, convulsions, bodily pains (head, stomach), malaria and vomiting (Table 1). The three main diseases/symptoms named (fever, diarrhoea and head pain) were also mentioned as being common side effects of vaccination, with diarrhoea and fever being the most frequently cited side effects of vaccination. They are followed by minor injury to the arm (swelling, soreness, bruising).

No consistent differences between the said normal diseases and those known to be fatal were found in their conceptualisation of the known bulk of childhood diseases. Among the symptoms or diseases enumerated by the participants, meningitis (or stiff neck) was the only one identified (on three occasions) as a fatal disease that is neither normal nor inevitable among children, and which it is consequently particularly important to prevent through vaccination.

Finally, when the participants were asked to tell at what age they thought children should be vaccinated to avoid these diseases, the majority replied "between the age of one and five".

The decision-making process

The data showed that among the communities studied, making the decision to accept, or not, the immunization of a child is mainly the role of the head of the household. According to the majority of the participants interviewed, the decision is made sometimes by the father alone, sometimes by the father's father (the paternal grandfather) and sometimes by the father and mother or grandmother together:

> "The father does make the decision for the vaccination." *Mossi grandmother*
>
> "The father makes the decisions in general." Primiparous *Marka mother*
>
> "If there is a grandfather, the father loses control, he won't be informed." *Primiparous Marka mother*
>
> "The father asks the grandfather. They decide together. They also ask the grandmother." *Marka father*
>
> "It belongs to the father. For girls, it last until their wedding." *Peulh grandmother*
>
> "Paternal grandfather and father." *Multiparous Peulh mother*
>
> "The father makes the decision. When he doesn't make the decision quickly, the mother can try to convince him." *Bwaba father*
>
> "The grandmother might be involved in the decision, particularly for the protection of the child." *Bwaba grandmother*
>
> "The father makes the decisions." *Primiparous Bwaba mother*
>
> "Everyone, but especially the mother." *Primiparous Mossi mother*

Among the different communities, the Bwaba and Mossi mothers can be involved in the decision-making. In the Marka and Peulh families, the grandfather seemed more present in the decision-making process. The grandmother was cited by the Bwaba and Marka as being part of the decision-making process.

As it has been said, the decision makers are generally in favour of vaccination given the fact that the vaccines are offered free of charge, and because, according to them, it keeps children healthy and prevents disease. However, it was also clearly stated during the focus groups and interviews that sometimes, despite the fathers' decision to vaccinate the children, the mothers do not always bring children to the immunization sessions offered.

"If the mother doesn't want to have her child vaccinated, she won't do it." *Primiparous Marka mother*

"The fathers make the decision, but if they don't take care, some women won't get their child vaccinated." *Marka father*

"It is the father [who accepts], it is the mothers who refuse and some women leaves and don't get their child vaccinated." *Mossi grandmother*

The only participants who maintained that the women always entirely respect their husbands' decision regarding vaccination were members of the Peulh community, in which the submission of women to their husbands is culturally more marked.

When the participants were asked about why, according to them, some mothers did not always attend vaccination sessions with their children, they gave three frequent types of answers. The first was that families were not informed "because they live too far away and didn't hear the public crier" (Multiparous Bwaba mother). The second concerned individuals who do not vaccinate their children because they "are travelling, people who are away or get there too late" (Bwaba grandmother). Finally, the third category encompassed a number of reasons all related to the mothers' behaviour:

"The mothers are afraid for their children when they hear the other children crying." *Multiparous Marka mother*

"Often, the mothers are busy working and after it's too late and it's over." *Primiparous Bwaba mother*

Either they said it was because they are afraid for their children, or they do not wish to or cannot interrupt their work in the house. The latter reason is the one most frequently evoked by various participants in the study.

The vaccination procedure

The last factor that emerged from the meetings with the selected participants is structural in nature and concerns in particular the problems associated with the procedure leading to acquisition of the vaccination booklet. The booklet can be obtained free of charge during one of the free antenatal consultations (ANC) offered at the CSPS. This booklet is required for the vaccinations offered in villages by vaccination officers during routine vaccination sessions, which is not the case during special vaccination campaigns; in these cases, the families are given a vaccination card. Having this booklet at the moment of the vaccination session seemed problematic for many participants:

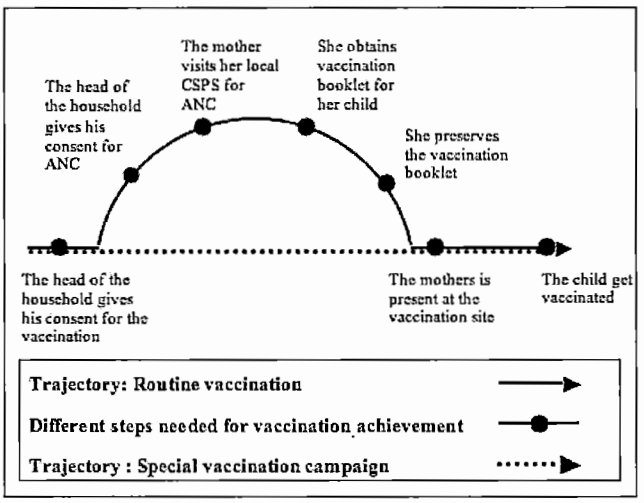

Figure 1 - Comparison of vaccination trajectories. Comparison diagram between routine vaccination activities and special vaccination campaigns.

"Vaccination is not available to mothers who don't have the child's booklet. So they have to return home or go and get the booklet from the CSPS." *Multiparous Bwaba mother*

The additional procedure involved in getting a child vaccinated during routine vaccination sessions, i.e. acquiring the booklet and having it for the session, implies four stages that have been revealed by and discussed with the participants. First, 1- the head of the household must give his consent for an ANC. Then, 2- the mother must visit her local CSPS for an ANC. 3- During this consultation, she must receive a free vaccination booklet for her child. Finally, 4- she must preserve the vaccination booklet in good condition until the birth of her child and afterwards for a period ranging from 11 months to two years. Figure 1 illustrates the difference between the procedure for obtaining vaccinations during routine vaccination sessions and during special vaccination campaigns.

This multi-stage procedure seemed problematic for the families interviewed, especially for the group of families in which the children's vaccination records showed numerous gaps. They expressed their concern that the procedure was far more complex than simply showing up at vaccination sessions or accepting vaccinations during the door-to-door visits made during special vaccination programs.

1- Consent by the head of the household for the ANC

In the first place, most of the heads of households spoken to who have neglected their children's vaccination revealed that they do not believe in the necessity of an

ANC during their wives' pregnancies. They consider motherhood to be a natural process that should not be medicalized. Many of the women revealed that either they or someone they knew had been refused vaccination for their child because they had not attended an ANC and therefore did not possess a vaccination booklet.

In addition, some heads of households interviewed were under the impression that they had to pay for an ANC. On questioning them more closely, it became clear that most of the first ANCs had taken place when the mother had gone to the CSPS because of illness, and that she had indeed been required to pay for a medical record (distinct from her child's vaccination booklet) and for the consultation, which was not considered to be a simple antenatal visit, but a full medical consultation, and was thus not offered free of charge.

2- Mother's trip to a CSPS for an ANC

According to the participants, even in cases where the head of the household has given his consent for an ANC, the distance the mother has to travel (between 5 and 10 km for the communities interviewed), often by foot, to reach the nearest CSPS and the time thus wasted discourages some mothers from making the trip, especially if their pregnancy is already far advanced.

Also, all the interviewed families whose children had a relatively good vaccination status and who possessed the most vaccination booklets were related to the VHO. The VHO is the principal source of information about health activities scheduled to take place in the village and about requirements for obtaining vaccinations, such as the acquisition of a vaccination booklet during an ANC.

It seems, according to the data, that these individuals have a greater influence over members of their own family than over the rest of the villagers, who frequently complained that they were only informed at the last minute about vaccination sessions being held in their village or about the need to procure a vaccination booklet during an ANC.

> "There's not enough information before the vaccination, the public crier should come more often before the vaccination sessions. Those who live alone or very far away don't get the information in time." *Multiparous Bwaba mother*

3- Acquisition of the child's vaccination booklet

Some of the questioned participants did not seem aware that the vaccination booklet required by vaccination officers is available to their child free of charge. Some were convinced they had to pay for the child's booklet, others even claimed to have refused to pay for booklets that had been offered them.

> "It's free [vaccination], there's no problem, but you have to pay from 25 to 100 CFA francs for the vaccination booklet, and this is why lots of people don't have their children vaccinated." *Multiparous Bwaba mother*

> "Vaccinations are good, but they give you fever and its costs money – to get fever! Also, they charge 25 CFA francs for the weighing and 150 CFA francs for the booklet." *Multiparous Peulh mother*

> "At a month old my child was vaccinated five times, but the booklet cost me 225 CFA francs." *Primiparous Mossi mother*

No data exists to assess exactly why they were charged for those vaccination booklets. It might be due to confusion between those booklets and maternity booklets or regular medical booklets that do have to be paid for, or it might be the price to get a lost or destroyed booklet replaced.

4- Preservation of the vaccination booklet

Preserving the vaccination booklet in good condition and not losing it seems to represent a major problem for the mothers interviewed. A number of mothers complained about how difficult it is to preserve a paper booklet, since for most of them there is no spot in the hut where they can place such a document out of reach of rain, termites and small children. As the mothers were asked to show their vaccination booklets and cards in order to check their children's vaccination status, it was possible to observe the condition of the booklets. Many of them were indeed gnawed by termites or soaked by rain, and were as a result unusable or unreadable.

Discussion

Most of the individuals who participated in focus groups or interviews and who failed to have their children completely vaccinated did not do so because they do not care for their children's health or because they strictly reject vaccination. The comments reported in the first part of the results reveal the parents' real preoccupation with their children's health and the general acceptance of vaccines. But, as it will be discussed now, some obstacles linked to their conceptualisation of childhood diseases and the appropriate age for vaccination, decision-making processes and vaccination procedure still hamper the achievement of good vaccination coverage in this particular area.

Childhood diseases

The common denominator between all symptoms/ diseases and side effects of vaccination that have been frequently named by participants is the ease with which they can be recognized and identified, even by people

who do not have a strong biomedical knowledge or who do not have access to sophisticated antigen tests. They are all distinct and highly noticeable expressions of an abnormal condition of the body. Also, the repetition of the experience of an illness in the immediate environment is the primary means for most of those individuals to acquire biomedical and traditional medical knowledge [17]. This may be the source of this frequent association between the normal childhood diseases/symptoms which are frequently observed, like fever or diarrhoea, and the fatal diseases. For instance, as children regularly show signs of fever or diarrhoea prior to death (due in part to the great burden of malaria and gastrointestinal parasites) and considering that the exact cause of death is usually not known because of the lack of biomedical screening tests or medical consultation, it is understood by the family that the fever, or diarrhoea *per se* is actually the main cause of death [17]. As all children get these symptoms at least once in their life, the disease is spontaneously considered to be "normal" and, as some children unfortunately die while presenting those common symptoms, the disease is also commonly considered as "potentially fatal".

The importance assigned by participants to the symptoms of diarrhoea and fever may constitute a problem in the effort to increase vaccination coverage rates. It could also negatively influence the perception of the vaccination itself. Numerous participants claimed to be in favour of vaccination on the grounds that it "keeps children healthy," "prevents disease" or "treats children." In fact, four of the vaccines used in the EPI target a single disease (BCG, AAV, MV, OPV-Oral Polio Vaccine); only one vaccine targets three diseases (DTP). Given the relatively limited effect of vaccines, their empirical efficiency may prove disappointing when a fully vaccinated child falls victim to diarrhoea or fever, especially if these conditions are the result either of the side effects of vaccination, of a less severe disease or a disease for which there is no available vaccine, such as malaria.

This empirical conception of childhood diseases may play a significant role in the low rates of vaccination coverage existing in the health district studied, particularly for vaccination programs taking place outside an epidemic context. It has been noted elsewhere that the shift from the use of vaccination to control epidemics in developing countries to its use in preventing epidemics that have not yet occurred can lead to a marked reduction in general optimism and in the demand for vaccination [13]. The spectacular effects of the former are not there to maintain the popularity of routine vaccination among the targeted populations. The difficulty lies in trying to convince the communities that vaccination does prevent some childhood diseases when, empirically, 1 - fever and diarrhoea keep on affecting children after vaccination, and 2 - fever and diarrhoea can be among the side effects of vaccination.

Also, the fact that a majority of participants thought the appropriate age to get their child vaccinated was over one year old might have a negative impact on the rate of vaccination coverage, especially when it comes to calculating the valid coverage rate regarding acquisition of all the vaccines available to children of less than a year. To be considered valid the Polio3, BCG, DTP3, VAA, and VAR vaccines must be received before the age of one. This finding is consistent with other studies in Sub-Saharan Africa where it is estimated that only 50% of the children living in that part of the world are vaccinated in the year after their birth [30].

The decision-making process

Because of the gender difference in the decision-making process, which is more pronounced among the Peulh community compared to the other groups studied, the head of the household is usually the main target of vaccination awareness campaigns. But the dual decision-making process, revealed by the data, involving first the father, who gives his consent, and then the mother, who for different reasons decides otherwise, demonstrates that actual vaccination awareness campaigns that still focus mainly on fathers need to be shifted towards the mothers to raise their awareness of the importance of vaccination for their child's health.

It is important to note here that the grandmother (mainly the paternal grandmother), who enjoys a higher social status than the mother and who possesses a certain influence over her grandchildren, especially in the Bwaba and Marka communities, could serve as a valuable promotional co-agent. It remains to be seen to what extent the grandmother could also be mobilized, in the husband's absence, to help, persuade and remind the mothers of the neighbourhood to set aside their other duties for a short while in order to take their children to a vaccination session.

The vaccination procedure

During special vaccination campaigns, it is necessary to raise awareness among heads of households in order to obtain tacit authorization for the child's vaccination. The door-to-door approach generally employed during such campaigns allows for an easier contact with a maximum number of families. For routine vaccination sessions, even greater effort must be put into raising awareness among village authorities and mothers as has just been discussed, in order to ensure that the mothers not only show up at the vaccination site but also that they obtain, during an ANC, the child's vaccination booklet and bring it with them in good condition.

1- Consent by the head of the household for the ANC

The mandatory institutionalization of pregnancy and birth and the obligation to attend an ANC in order to obtain the child's vaccination booklet appeared to be a major obstacle to the vaccination of children in the villages concerned.

In sub-Saharan Africa, we estimate that only 44% of all women receive a full ANC, so we can assume that around 56% of mothers risk not having the vaccination booklet in time for their child [31-33].

What is important here is that the various communities are being asked not only to accept vaccination for their newborns and to be present at vaccination sessions as in the case of special vaccination campaigns, but also – in addition to all the difficulties outlined above – to accept the ANC, thus considerably increasing the cases of parental negligence and passive refusal with regard to vaccination.

2- Mother's trip to a CSPS for an ANC

There is no doubt that the fatigue engendered by a long walk and the time taken away from the mothers' household duties have a negative impact on campaigns aimed at raising awareness about the importance of ANCs, and by extension on campaigns designed to raise awareness about the need to have children vaccinated. Access to health care thus becomes a major obstacle in the achievement of vaccination, despite the good intentions of health authorities who, having pronounced themselves in favour of an advanced vaccination strategy, ensure that vaccination sessions are generally held in the centre of each village.

Asking mothers to make the trip to the nearest CSPS during their pregnancy undermines the increased access to services offered by advanced vaccination strategies and, as a result, potentially reduces vaccination coverage. The advanced vaccination strategy of the EPI has contributed considerably to the increase in vaccination coverage in Burkina Faso since the early 1980s [34,35]. In that context, it might be worthwhile to introduce a similar strategy for ANCs, thus ensuring that mothers acquire the child's vaccination booklet and at the same occasion receive the anti-tetanus vaccine, which is, after all, the child's very first vaccine that should be received while still in the mother's womb.

3- Acquisition of the child's vaccination booklet

The comments of the participants stating that they have to pay for the child's vaccination booklet may result from some families confusing the vaccination booklet, which is free, with the regular medical or maternity booklets, or with subsequent replacement booklets, which they are asked to pay for. Another anthropological study in the West African context exploring the population perception of the EPI exposed similar findings, linking the booklet acquisition problems and the actual vaccination achievement [25]. Boa's study in the semi-rural department of Bouna in the Northwest of the Ivory Coast revealed that the over billing of the vaccination booklet was leading to passive refusal of vaccination [25]. More research is needed here to determine if this is the case or not in the health district of Nouna, Whether it is or not, however, it is vital that the various communities be informed that the vaccination booklet is entirely free when requested during an ANC, so as to ensure that no more mothers are refused vaccination for their child owing to the lack of a booklet.

4- Preservation of the vaccination booklet

Mothers who lose their child's booklet or who are presenting a booklet in bad condition to a vaccination officer are sometimes refused vaccination for their child, thus adding a new group of unvaccinated children to those who are refused vaccination because their mother has not previously procured a booklet during an ANC.

Vaccination booklets are in principle intended as reference documents that the parents can consult to keep track of their child's vaccination status. However, they include no pictograms and are therefore of no use to most parents, who are illiterate and cannot read the information it contains. The fact that parents use the booklet only on the occasion of vaccination sessions increases the risk that it will get lost, be destroyed or becomes unusable. According to Dabiré [36] who worked on this issue in Ouagadougou, Burkina Faso, mothers, because of their illiteracy, do not appreciate the importance of the booklet, and end up losing it. The loss of booklets has also been evoked by researchers in other contexts, including by Tremblay [37] in Haiti and Millimouno [15] in Guinea, where both have indicated that the booklet was easily and frequently lost. Each has also established that those losses have contributed to the non-vaccination of children.

The sense of shame experienced by mothers as a result of the loss or poor state of their booklets, which was also observed during this study when they showed them to the researchers for verification, is undeniable, for it is in some sense a reflection of their poverty and illiteracy. But when this feeling is triggered by public reproach from the vaccination officer during vaccination sessions, and when a mother is harshly criticized in front of other mothers for failure to keep her booklet in good condition, this can create a genuine aversion to the whole vaccination process. A mother singled out in this way may simply decide to stop attending vaccination sessions, and her name will be added to the already far too lengthy list of parents who fail to have their children vaccinated.

For those reasons, it might be worth evaluating the cost-effectiveness of introducing changes that would enable mothers to keep track of their children's vaccination status, such as producing an illustrated booklet, facilitating preservation of the booklets by coating them with plastic, or adopting a centralized tracking system.

Conclusions

The procedures parents must follow in order to obtain vaccination for their children appear complex and constraining, and on certain points discord with the traditional systems of meaning and idioms of distress related to pregnancy, the prevention of childhood diseases and with the cultural matrix shaping decision-making and behaviour. Promotional and awareness campaigns conducted among these populations have proved fruitful. Attention now needs to be directed at certain promotional, logistical and structural elements, and at the procedure that must currently be followed to obtain vaccination for a child during routine vaccination sessions, which are currently limiting the active demand for vaccination.

It must be acknowledged, however, that the results and conclusion that have been presented here are very specific to this particular setting, the health district of Nouna, and thus can not be applied generally to all situations in which are found low levels of coverage coupled with low levels of opposition to immunisation. This constitutes a limit to this study. However, the research question might still hold valid in the search to find culturally and contextually sensitive answers and solutions for the benefit of other populations experiencing a similar situation.

List of abbreviations used

AAV – Anti-Amaril vaccine; ANC – Antenatal consultations; BCG – Bacillus Calmette-Guerin; CRSN – Centre de Recherche en Santé de Nouna (Nouna's health research centre); CSPS – Centres de santé et promotion sociale (peripheral health posts); DTP – Diphteria-Tetatus Petussis Vaccine; EPI – Expanded Program on Immunization; ETUVAC – Étude sur la vaccination (Vaccination study); MV – Measles vaccine; VHO – Village health officials; WHO/ECHO – World Health Organisation/European Commission's Humanitarian aid Office.

Competing interests

The authors declare that they have no competing interests

Authors' contributions

MD participated in the design of the study, carried out the field studies, analysed the data and drafted the manuscript. ED carried out the field studies, contributed in the analyses of the data and drafted the manuscript. BK conceived the study, participated in its design and coordination and critically revised the draft. AS participated in the design of the study and critically revised the draft. GB conceived the study, participated in its design and coordination and helped to draft the manuscript. All authors read and approved the final manuscript.

Additional material

Additional file 1

Abstract in French.
Available from:
http://www.biomedcentral.com/content/supplementary/1472-698X-9-S1-S9-S1.doc

Acknowledgements

This work was carried out with the aid of a grant from the International Development Research Centre (IDRC), Ottawa, Canada, as part of the Canadian International Immunization Initiative Phase 2 (CIII2). This initiative is a project of the Global Health Research Initiative (GHRI).

The authors would like to thank the team of the Centre de Recherche en Santé de Nouna (CRSN). Many thanks to all co-investigators who participated to the ETUVAC study: Gilles Bibeau (PI), Bocar Kouyaté (PI), Aboubakary Sanou, Marylène Dugas, Maurice Ye, Jean-Claude Robert Lucien Kargougou. Special thought go to the coordinator of this study, Florent Somé, who tragically died in August 2005.

This article is published as part of *BMC International Health and Human Rights* Volume 9 Supplement 1, 2009: The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants. The full contents of the supplement are available online at http://www.biomedcentral.com/1472-698X/9?issue=S1.

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Assessment of factors associated with complete immunization coverage in children aged 12-23 months: a cross-sectional study in Nouna district, Burkina Faso

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from The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants

Published: 14 October 2009

BMC International Health and Human Rights 2009, **9**(Suppl 1):S10 doi:10.1186/1472-698X-9-S1-S10

This article is available from: http://www.biomedcentral.com/1472-698X/9/S1/S10

Abstract

Background: The Expanded Program on Immunization (EPI) is still in need of improvement. In Burkina Faso in 2003, for example, the Nouna health district had an immunization coverage rate of 31.5%, compared to the national rate of 52%. This study identifies specific factors associated with immunization status in Nouna health district in order to advance improved intervention strategies in this district and in those with similar environmental and social contexts.

Methods: A cross-sectional study was undertaken in 41 rural communities and one semi-urban area (*urban in the text*). Data on 476 children aged 12 to 23 months were analyzed from a representative sample of 489, drawn from the Nouna Health Research Centre's Demographic Surveillance System (DSS) database. The vaccination history of these children was examined. The relationships between their immunization status and social, economic and various contextual variables associated with their parents and households were assessed using Chi square test, Pearson correlation and logistic regression.

Results: The total immunization coverage was 50.2% (CI, 45.71; 54.69). Parental knowledge of the preventive value of immunization was positively related to complete immunization status ($p = 0.03$) in rural areas. Children of parents who reported a perception of communication problems

surrounding immunization had a lower immunization coverage rate ($p < 0.001$). No distance related difference exists in terms of complete immunization coverage within villages and between villages outside the site of the health centres. Children of non-educated fathers in rural areas have higher rates of complete immunization coverage than those in the urban area ($p = 0.028$). Good communication about immunization and the importance of availability of immunization booklets, as well as economic and religious factors appear to positively affect children's immunization status.

Conclusions: Vaccination sites in remote areas are intended to provide a greater opportunity for children to access vaccination services. These efforts, however, are often hampered by the poor economic conditions of households and insufficient communication and knowledge regarding immunization issues. While comprehensive communication may improve understanding about immunization, it is necessary that local interventions also take into account religious specificities and critical economic periods. Particular approaches that take into consideration these distinctions need to be applied in both rural and urban settings.

Abstract in French: See the full article online for a translation of this abstract in French.

Abstract in French

See Additional file 1 for a translation of the abstract to this article in French.

Background

Immunization has a long history of success. Studies have shown that it has an impact on the major causes of infant death and that it shapes trends of mortality and morbidity among communities [1,2]. Immunization remains one of most cost-effective health interventions [3,4] and has proven to prevent up to 24% of the 10 million yearly deaths of children under five [5]. Nevertheless, vaccination has always faced multiple adversities [6-11], the most recent being the suspicion that it is an international conspiracy against selected communities, particularly those in developing countries [12-15].

To benefit from its full potential, including the positive externalities for non-immunized children, the World Health Organization (WHO) suggests that complete vaccination coverage should reach at least 90% of children at the country level and 80% in sub-areas by the year 2010 [16]. Such an ambitious objective is far beyond the actual reach of most developing countries for several reasons. While in the Netherlands, for example, the perception of risk of infection is a determining factor in the decision of Dutch parents to vaccinate their children [17], daily living conditions determine whether parents seek immunization for their children in many developing regions. In Kinshasa, for example, there is a reported strong association between specific vaccines and mothers' education level [18]. Higher socio-economic condition of the parents is also associated with greater probability of the child being vaccinated under a routine vaccination program compared to mass vaccination campaigns [19]. Knowing what is at stake is also important in vaccination seeking behaviour [20]; not participating in immunization sessions appears to be linked to lack of information amongst parents [21] or to a deliberate choice to refuse [17,22]. Residing near health facilities has also been considered a strong determinant for getting good vaccination coverage [23,24]. In reality, however, this is not always the case since areas in the vicinity of health services often show weak immunization coverage [25].

Ethnic disparities in vaccination rates have been reported in countries like Mali, Niger and Senegal, where, respectively, the Bambaras, Djermas-Songhais and Sérères appear to have more complete immunization coverage [26]. Similarly, in the United States, racial and ethnic differences are reflected in influenza vaccine coverage [27]. Vaccination uptake is thus considered to be highly culturally sensitive, influenced by local perceptions on childhood diseases and decisional processes in households [28]. While some authors emphasize that vaccination uptake has a cultural foundation in some African communities[11,29-33], others attribute low achievement of immunization to cultural discrepancies [6, 34-36] and some etiological considerations regarding preventable diseases have even been identified as "cultural prejudice" [12].

While the literature shows the importance of social, economic, geographic and cultural factors in the vaccination status of a child, achieving adequate vaccination coverage is not only related to the attitudes and capabilities of parents. Researchers have demonstrated that the organization and functioning of the health care system and services, including the ways health workers perform their activities, constitute key elements in vaccination coverage: it is known that the manner in which immunization activities are organized and services are delivered [6], and the interaction between parents and health workers [9,31] greatly influence the immunization coverage. Unfortunately these aspects are not always taken into consideration by health workers or by the planners of vaccination services.

The quality of the service at the health post with regards to reception, waiting time [24,31], and good clinical practice [37] also affect demand for immunization.

The success of immunization activities is also associated with the strategies used to reach target populations and to deliver service. Generally, two major health service strategies are utilized complementarily: i) routine vaccination activities are performed by using a combination of mobile and fixed-point strategies or advanced strategies for remote villages; and ii) targeted campaigns are undertaken to complement routine activities and to avoid the emergence of specific epidemics (particularly meningitis and measles). These latter campaigns are however said to be costly [38]. Immunization improvement can adopt *risk based strategies* (who should be vaccinated?) or *place based strategies* (where to vaccinate?) [5]. Strategies that enhance immunization coverage also include approaches that improve demand for immunization, address access to immunization services, compulsory immunization, and adopt provider based strategies [39]. Any combination of these approaches is also possible [40,41].

The Expanded Program on Immunization (EPI) is far from achieving the success experienced by the smallpox eradication program, which is said to have inspired the launching of the EPI in 1974 [42]. In Burkina Faso in 2003, the complete immunization coverage of children aged 12 to 23 months for the six preventable diseases targeted by the EPI was 52%; 3% of these children had never been vaccinated. Sub-area coverage varies greatly, ranging from 18% to 79%. The Nouna health district, for its part, had one of the lowest complete immunization coverage rates, 31.5%, and 5.2% of children aged 12 to 23 months had received no vaccinations. [22].

Through an operational research grant provided by the International Development Research Centre (IDRC) as part of the Canadian International Immunization Initiative Phase 2 (CIII2), an intervention was planned by the Centre de Recherche en Santé de Nouna (CRSN) and the Nouna health district to address this low coverage rate. As part of the planning for that intervention, the CRSN carried out studies to assess the various social, cultural, anthropological and economic factors leading to non-vaccination as well as assess the actual vaccination coverage rates.

This article provides evidence of the issues that appear to be related to complete and incomplete immunization coverage when taking into account details of the communities and the existing structure and provision of health services. As can be seen from the diverse range of strategies reported above, improving immunization coverage in the Nouna district will require concrete knowledge and responsiveness to the particular issues associated with low coverage in this region. The results of the study reported here provide additional information for constructing local interventions to tackle problems of low coverage in the Nouna district as well as other areas with similar conditions. They will also be important for the 2006–2015 decade target of international institutions such as WHO and UNICEF to reach all disadvantaged areas [43].

Study location

The study area is the health district of Nouna, in the North-West of Burkina Faso, about 300 km from Ouagadougou, the capital city. The district has a district hospital, the Centre de Santé avec Antenne chirurgicale (CMA) and 24 peripheral health centres called Centre de Santé et de Promotion Sociale (CSPS), with each of these peripheral health centres being run by a team of two to four health workers and one to three unqualified volunteers. The district hosts the CRSN, which includes a Demographic Surveillance System (DSS), and covers a population of around 70,000 in 57 villages and the town of Nouna with its seven sectors. The population is composed of several ethnic groups including two native groups (Marka and Bwaba) as well as the Samo, Mossi and Fulani. The people in the region are predominantly Muslim, with some percentage of the population being Christian [44, 45]. Three quarters of the population is illiterate, dependent on subsistence farming and livestock breeding. The average family size is 10 individuals with some compounds composed of multiple generations. The principal language spoken is Djoula, used by almost all the ethnic groups. The study area includes the district hospital, the urban health centre and nine peripheral health centres. Epidemic and endemic diseases, some of which are preventable through vaccination, dominate the epidemiological profile. Local cultural belief systems influence etiological explanations of diseases and health-seeking behaviour is dominated by traditional medicines. It should be noted that, in this area, malaria remains the primary cause of morbidity and mortality, particularly among children.

Methods

Sample and procedure

This research is a cross-sectional study planned as a pre-intervention assessment. A sample of 489 children aged 12 to 23 months was calculated using the Epi-Info Statcalc with a 95% confidence level, a power of 80%, and 46% as the estimated immunization coverage rate in the research area (this rate was estimated by the research team, based on their knowledge of the local context). The sampling was carried out using the database of the DSS of CRSN, which contained 2,508 households with children in the targeted age group. The number of households to visit in each village was determined according to the proportion of 12 to 23 month-old children in the village

from the database. The codes of all the households of a village were written on pieces of paper and then the households were drawn (without replacement) until the required number for the village was obtained. The household was identified using this code and the name of the head of the household. Children were identified using their name and the name of the parents. An appointment was set with the parents; only one child was selected per household. Of 489 children selected, 13 children were not included in the analysis: two children had deceased, five households migrated with their children and the data quality checking procedures rejected four entries for insufficient information and two other children were excluded because they did not belong to the eligible age group. The analyses were performed with a final sample of 476 individuals. There were no refusals.

The questionnaire and data collection

The questionnaire was built following an adapted household survey questionnaire that is used in the DSS; in addition, a number of focus group discussions were held a month before we framed the questionnaire. The revised questionnaire contains six categories of data: 1) identification of the household and the child; 2) family information extracted from the DSS data base; 3) socio-economic status information; 4) perception about risk and decision of prevention; 5) birth place of the child and exposure to vaccination information; and 6) knowledge about immunization and participation in prevention sessions. The economic status of households was determined from information gained from interviewees. A basic or *core economical revenue* of the household was estimated on the basis of the revenue from the principal activity of the head of the household in addition to the assets (agricultural production, cattle and poultry) of the household. While we recognize that the *core economic resource* does not provide an account of the total financial resources of the household, it does provide a measurable economic indicator for comparison.

In a section dealing with the mother's participation in immunization activities – i.e. presenting at vaccination sites (vaccination sites are selected fixed places in villages where immunization take place) – and knowledge about immunization, information was also collected on immunization uptake (the principal dependant variable). Information was collected from immunization documents and from the mothers' statements, as suggested by many authors [46,47]. To guarantee the accuracy of this information, we examined multiple written sources used for immunization documentation including the immunization record cards, the prenatal consultation booklet of the mother, the infant files of the health centre and the immunization record book of the village health worker. Verbal information from the mother concerning each vaccine uptake was sought and a direct observation of the BCG scar was performed on the child. The final information obtained by the mother from health workers was also recorded. Responses such as: *"we've been told that our child was too old for this vaccine"* or *"the nurses said the child has got all his vaccines"* were used to correct the final immunization status. It should be noted that mothers give great importance to this final information.

The vaccination sessions are held in locations known as vaccination sites, identified by health workers and communities in the villages. The geographical coordinates of these vaccination sites were taken using a Global Positioning System (GPS). The distance between the household and the vaccination site was then ascertained for inclusion as a variable in the final analyses. The Average Theoretical Range of Action (ATRA) for health centres in 2004 in Burkina Faso was 8.3 km. This indicator was used for scaling the distance from the child's village to the health centre (0 = 0 km, representing residence in a village that has a health centre, 1 = residential distance between 1 km to 8.3 km away from the closest health centre, 2 = 8.4 to 16.6 km, 3 = 16.7 to 24.9 km and 4 ≥25 km). This was used to analyse the relationship between immunization uptake and residential distance from a health centre.

Taking into account the multiethnic characteristics of the study population, 18 representative interviewers participated in the data collection after a week-long training session. Two Masters level (MSc.) research coordinators supervised the interviewers. Both men and women were interviewed in the households. The completeness, logical structure and acceptability of the responses were checked in the field and at the office before we transferred the questionnaires for data entry.

Data analysis

Data entry was performed using ACCESS and tables were transferred into Epi-Info and SPSS. Relative frequencies and other descriptive statistics were performed to present the distribution of the independent variables and vaccine uptake. Non-parametric analysis using *chi square test* was used to analyze the relation between the vaccination status of the child and the independent variables. A child was considered completely vaccinated if s/he received the BCG vaccine, the four doses of oral polio, three doses of DTP, measles and yellow fever vaccine. This study did not consider the validity of the dose of vaccines received (i.e. whether vaccines were administered in compliance with the vaccination schedule). After dichotomization, the independent variables were examined in a correlation analysis using Pearson's correlation coefficients to detect potential collinearities in the logistic regression and lead to appropriate data analysis and reporting [48,49]. The

Table 1 - Characteristics of study participants.

Variables	Number of children (n)	Percentages (%)
Sex of child		
Male	228	47.9
Female	248	52.1
Total	476	100.0
Availability of a vaccination record document		
No	127	26.7
Yes	349	73.3
Total	476	100.0
Locality		
Urban	127	26.7
Rural	349	73.3
Total	476	100.0
Birth place		
At a health center	188	39.5
Home and elsewhere	288	60.5
Total	476	100.0
Distance from village to health centre (range)		
0 (0 km)	181	38.0
1 (1 to 8.3 km)	121	25.4
2 (8.4 to 16.6 km)	111	23.3
3 (16.7 to 24.9 km)	50	10.5
4 (more than 25 km)	13	2.7
Total	476	100.0
Father's school attendance		
None	254	53.4
Muslim Koranic	71	14.9
Formal	151	31.7
Total	476	100.0
Mother's school attendance		
None	355	74.6
Muslim Koranic	41	8.6
Formal	80	16.8
Total	476	100.0
Mother's attendance in literacy classes		
No	424	89.3
Yes	51	10.7
Total	475	100.0
Father's religion		
Muslims	295	62.0
Christians	140	29.4
Animist and other religion	41	8.6
Total	476	100.0
Monogamous		
No	209	43.9
Yes	267	56.1
Total	476	100.0
Polygamous		
No	292	61.3
Yes	184	38.7
Total	476	100.0
Household ethnic group		
Bwaba	107	22.5
Marka	205	43.1
Mossi	94	19.7
Foulani	24	5.0
Samo	39	8.2
Others	7	1.5
Total	476	100.0
Father's profession		
Agriculture	412	86.6
Others	64	13.4
Total	476	100.0
Quartiles of revenue (In CFA francs)		
1st (0 to 146475)	119	25.0
2nd (146475.1 to 332125)	119	25.0
3rd (332125.1 to 595375)	119	25.0
4th (595375 to Highest)	119	25.0
Total	476	100.0

(Continued in next column)

Table 1 - Characteristics of study participants *(Continued)*.

independent variables that showed significance for complete vaccination uptake were included in the logistic regression analyses. Given that in the rural areas many more variables proved significant in relation to the dependant variables, we excluded Nouna town from the regression analysis. Finally, interpretation of our findings takes into account the literature, context and purpose of the study.

Results

Characteristics of study participants

Table 1 indicates that the data relate to 476 children, 228 (47.9%) boys and 248 (52.1%) girls between 12 and 23 months of age. Children residing in the town of Nouna represented 26.7 % (127) while the remaining came from surrounding villages. Nearly 40% of the children were born in health facilities and 38% were residing in a village hosting a health centre. The majority of fathers (53.4%) and mothers (74.6%) attended no school or had received Islamic religious teachings through Koranic schooling (respectively 14.9 % and 8.6%). Some mothers attended adult literacy classes (10.7%). The majority of parents were Muslim (295/476), while Christians represented about 30% and local belief systems 8.6%. The dominant marital status was monogamous (56.1%) followed by polygamous (38.7%). Three ethnic groups composed the majority of the study population: Marka 43.1%, Bwaba 22.5% and Mossi 19.7%. The principal activity of the parents was agriculture (86.6%). The mean estimated core annual revenue of the households was 509373 CFA francs, ranging from 1500 CFA francs to 6600000 CFA francs (1 USD is worth approximately 450 CFA francs).

Table 2 - Objectives of immunization according to respondents.

Objectives of immunization	Numbers of respondents	Percentages (%)	95% CI	
Don't know	49	10.29	7.57	13.03
Prevent disease	284	59.66	55.29	64.11
For health (without precision)	136	28.57	24.54	32.66
It's for a specific disease (mainly polio)	7	1.48	0.41	2.59
Total	476	100		

Table 3 - Parents' knowledge. Availability of booklet. Perception of communication problem and vaccination uptake.

	Not completely vaccinated	Completely vaccinated	$p \leq 0.05$
Knowledge of the preventive objectives of immunization			
Illiterate father	**Total = 325; n (%)**		
Don't know or it's for a specific disease	27 (15.7%)	12 (7.8%)	
To prevent diseases or for child health	145 (84.3%)	141 (92.2%)	0.030
Availability of a vaccination record document	**Total = 357; n (%)**		
No	68 (35.6%)	29 (17.5%)	
Yes	123 (64.4%)	137 (82.5%)	0.000
Perception of communication problems			
Rural area	**Total =349; n (%)**		
Did not perceive communication problem	41 (24.8%)	80 (43.5%)	
Perceived communication problem	124 (75.2%)	104 (56.5%)	0.000

Immunization coverage and knowledge about vaccination activities

The complete immunization coverage was 50.2% (CI: 45.71–54.69) with 2.52% (CI: 1.10–3.90%) having never been vaccinated. Table 2 reveals that 59.7% of parents (CI: 45.71–64.11) knew that the objective of vaccinating children was to prevent disease, while 10.29 % (CI: 7.57–13.03) of parents said they had no idea about the objectives of vaccination; for others, all vaccinations are to prevent specific diseases like poliomyelitis. Vaccination records were available for 73.3% of children. The majority of respondents identified poliomyelitis (66.4%) as the primary example of vaccine-preventable disease, followed by malaria (31.87%). Tuberculosis (1.87%), whooping cough and diphtheria (<1%) were given less consideration as preventable diseases.

Respondents were asked about specific concerns that prevented them from participating in vaccination sessions. From the 476 respondents, 318 (66.8%) mentioned communication problems (they did not understand what the health workers wanted; they thought their child was totally immunized); 5% (25/476) complained about the organization of immunization sessions (e.g. *"health workers don't stay in the village for enough time; they come too late, they discriminate against some children"*).

Factors associated with complete immunization coverage

Knowledge, vaccination documents and immunization uptake

Knowledge about the reasons for immunization and complete immunization coverage were found to be associated with the parents' level of education. Children of non-educated fathers who reported no knowledge of the objectives of immunization were less likely to be completely vaccinated (Table 3). Although there was a strong relation between the availability of vaccination documents and complete vaccination status, this relation was only significant in rural areas and not significant for children of the highest income group ($p < 0.001$). In rural settings, the perception of communication problems between parents and health workers was significantly associated with complete immunization coverage. There was no significant association with those living in the urban area of Nouna.

Geographic factors, locality, birthplace, distance of vaccination site and immunization

Table 4 shows that children in rural areas have a more complete immunization coverage rate than those in the urban area among non-educated fathers and mothers ($p = 0.028$ for fathers and 0.026 for mothers). Children born at health facilities in the villages have a more complete immunization coverage rate compared to those born at health facilities in Nouna town (52.5% versus 47.5%, $p = 0.003$).

The mean distance from households to vaccination site was 453.7 m; 432.5 m (SD: 476.2) for completely vaccinated children and 475.16 m (SD: 400.23) for not completely vaccinated ones. As to intra-village variation, children in close proximity to the vaccination site had no advantage in terms of complete vaccination coverage rate.

Table 4 - Relation between locality, birth place, distance to the vaccination site and vaccination uptake.

Locality	Not completely vaccinated	Completely vaccinated	$p \leq 0.05$
Urban/rural			
Illiterate father	**Total = 325; n (%)**		
Urban	48 (27.9%)	27 (17.6%)	
Rural	124 (72.1%)	126 (82.4%)	0.028
Illiterate mother	**Total = 396; n (%)**		
Urban	55 (26.7%)	33 (17.4%)	
Rural	151 (73.3%)	157 (82.6%)	0.026
Birth place	**Total = 476; n (%)**		
Born at health facilities	87 (36.7%)	101 (42.3%)	
Born out of health facilities	150 (63.3%	138 (57.7%)	0.215
Born at health facilities	**Total = 188; n (%)**		
Urban	60 (69.0%)	48 (47.5%)	
Rural	27(31.0%)	53 (52.5%)	0.003
Born outside health facilities	**Total = 288; n (%)**		
Urban	12 (8.0%)	7 (5.1%)	
Rural	138 (92.0%)	131 (94.9%)	0.317
Distance from household to vaccination site	**Total = 476; n (%)**		
1 0–250 meters	83 (35.0%)	89 (37.2%)	
2 >250–500	64 (27.0%)	72 (30.1%)	
3 >500–750	50 (21.1%)	41 (17.2%)	
4 >750–1000	19 (8.0%)	21 (8.8%)	
5 >1000 +	21 (8.9%)	16 (6.7%)	0.674
Distance from village to health center (range)			
Rural	**Total = 349; n (%)**		
0 (0 km)	22 (13.3%)	47 (25.5%)	
1 (1 to 8.3 km)	59 (35.8%)	47 (25.5%)	
2 (8.4 to 16.6 km)	49 (29.7%)	62 (33.8%)	
3 (16.7 to 24.9 km)	29 (17.6%)	21 (11.4%)	
4 (more than 25 km)	6 (3.6%)	7 (3.8%)	0.015

Considering the distance between the village of residence of the child and the health centre, the mean distance was 6.8 km (SD: 7.67); 6.6 (SD: 7.69) for vaccinated and 7.0 (SD: 7.66) for not completely vaccinated. There was a significant difference between the distance from the child's village to the health centre and immunization uptake (χ^2 = 12.298, df = 4; p = 0.015). The correlation between the range of distance from village to health centre (dichotomized in 0 = 0 and 1 to 4 = 1) and complete immunization coverage is significant (r = -0.153, at p = 0.01 level; Table 5). Rural children living in villages hosting the health centres tend to have better coverage.

Social factors (education, religion, marital status) and immunization uptake

Table 6 shows children from non-educated fathers were less immunized in the urban area (n = 127). In rural settings, the adult literacy of the mother was found to significantly determine vaccine uptake; 13.7% of the children of literate mothers were completely vaccinated compared to 6.7% of the non-vaccinated (p = 0.032). After controlling for both locality (rural/urban), and economic status, we notice that in rural areas, in the poorer three quartiles, children from Muslim families had lower immunization coverage rates (48.86%) compared to others (51.2%) (p = 0.011 n = 253). Children of polygamous fathers were more likely to have an incomplete vaccination status in rural areas. Marital status and religion were not significantly related to lower immunization coverage rate in the urban area.

Economic factors and immunization uptake

With regards to the principal economic activities of parents, no significant difference was noticed between children of farmers and others. Table 7 provides the analysis of the core revenue of the household. After controlling for locality and education, it appears that children of non-educated fathers among the higher fourth quartile (households earning more than 595375 CFA francs/year) had better immunization coverage compared to children of non-educated fathers among the poorer three quartiles (earning less than 595375 CFA francs/year). Children of

Table 5 - Correlations between study variables (rural areas).

	1	2	3	4	5	6	7	8	9	10	11	12	13
1 Complete vaccination	1												
2 Knowledge of the objectives of vaccination	0.072	1											
3 Perception of communication problems	-0.195**	-0.017	1										
4 Availability of vaccination record card	0.216**	-0.043	-0.127*	1									
5 ATRA (8.3 km)	-0.153**	-0.045	0.001	-0.179**	1								
6 Birth place	-0.148**	-0.031	-0.025	-0.147**	0.756**	1							
7 Father's religion	0.163**	0.159**	-0.029	-0.055	-0.308**	-0.242**	1						
8 Education of the father	0.074	-0.018	-0.169**	0.136*	-0.198**	-0.110*	0.201**	1					
9 Education of the mother	0.096	0.063	-0.146**	0.092	-0.154**	-0.140**	0.178**	0.224**	1				
10 Adult literacy of the mother	0.115*	0.049	0.089	0.067	-0.142**	-0.154**	0.208**	0.037	0.139**	1			
11 Monogamous marital status	0.148**	0.052	-0.110*	0.041	-0.050	0.008	0.193**	0.052	-0.006	0.084	1		
12 Polygamous marital status	-0.133*	-0.042	0.084	-0.050	0.042	-0.037	-0.213**	-0.104	-0.010	-0.088	-0.900**	1	
13 Economic status	0.133*	0.012	0.017	0.041	-0.049	-0.046	-0.028	0.082	0.094	0.001	-0.119*	0.147**	1

** The correlation is significant at 0.01 level (bilateral).
The correlation is significant at 0.05 level (bilateral).
Variable ATRA dichotomised in 0=0 and ATRA 1 to 4=1.

non-educated fathers of the forth quartile represent 32.5% of the completely vaccinated group and only 17.7% of the unvaccinated group ($p = 0.017$) in rural settings ($n = 250$).

Characteristics of completely vaccinated children (focus on rural area)

This part of the analysis was restricted to rural areas (349 children). We excluded from this analysis those variables that were not associated with vaccination status in the preceding steps, such as sex, distance from the household to the vaccination site, membership of the mother with an association (societies), and principal activities of the father. The remaining variables were dichotomized. The Pearson correlation test was then performed with variables that showed to be related to the dependant variables. As presented in Table 5, from 12 independent variables, three variables (knowledge of the objectives of immunization, $r = 0.072$; education of the father, $r = 0.074$; and education of the mother, $r = 0.097$) showed no significant correlation with the immunization status. All these variables were excluded from further analyses. In addition, the mother's attendance in literacy classes was also excluded because of the small number of cases.

Before proceeding to our analysis, we split the remaining variables into two groups. Variables related exclusively to the household formed one group (religion, monogamous marital status, polygamous marital status, and economic status) and variables related to the health system formed the other group (perception of problem of communication, availability of vaccination document, distance to the health centre, and place of birth). A stepwise logistic regression was performed on vaccination status entering group 1 variables at the first step and group 2 variables at the second step.

The Hosmer-Lemeshow test of goodness of fit was not significant (khi2 = 5.516, df = 7; significance = 0.597), indicating that the model fits the data. The Nagelkerke R2 is 0.186; the total percentage of correct classification of the model is 66.2% (the intercept only model was 52.7% and the step 1 model indicated 61% of correct classification). Results from the final model, in Table 8, suggest that children from households where vaccination documents were available are 2.4 times more likely to be in completely vaccinated groups (OR = 2.381; 95% CI = 1.436–3.948). The perception of communication problems by parents decreases the chance of being completely vaccinated by 0.46 (OR = 0.461; 95% CI = 0.283–0.750) and the household being in the forth quartile of the economic strata increased the likelihood of complete vaccination by 2.1 (OR = 2.1; 95% CI = 1.24–3.55). Being of non-Muslim religion increased the chance of being in the completely vaccinated group by 1.8 (OR = 1.811; 95% CI = 1.102–2.985).

Table 6 - Relation between social factors and vaccination uptake.

Variables	Not completely vaccinated	Completely vaccinated	$p \leq 0.05$
Urban			
Education of the father	**Total = 127; n (%)**		
Not educated	48 (66.7%)	27 (49.1%)	
Educated	24 (33.3%)	28 (50.9%)	0.046
Education of the mother	**Total = 127; n (%)**		
Not educated	55 (76.4%)	33 (60.0%)	
Educated	17 (23.6%)	22 (40.0%)	0.047
Rural area			
Mother's attendance in literacy classes	**Total = 348; n (%)**		
Illiterate	154 (93.3%)	158 (86.3%)	
Literate	11 (6.7%)	25 (13.7%)	0.032
Membership of the mother in associations	**Total = 474; n (%)**		
Not member	189 (80.1%)	178 (74.8%)	
Member	47 (19.9%)	60 (25.2%)	0.168
Rural area			
Monogamous parents	**Total = 349; n (%)**		
No	88 (53.3%)	71 (38.6%)	
Yes	77 (46.7%)	113 (61.4%)	0.006
Polygamous parents	**Total = 349; n (%)**		
No	87 (52.7%)	121 (65.8%)	
Yes	78 (47.3%)	63 (34.2%)	0.013
Religion (rural three lowest economic quartiles)	**Total = 253; n (%)**		
Muslim	85 (65.4%)	60 (48.8%)	
Others	45 (34.6%)	63 (51.2%)	0.011

Table 7 - Relation between economic status and vaccination uptake.

Variables	Not completely vaccinated	Completely vaccinated	$p \leq 0.05$
Profession *All participants*	**Total = 476; n (%)**		
Farmers	209 (88.2%)	203 (84.9%)	
Others	28 (11.8%)	36 (15.1%)	0.299
Economic status of household			
Rural area, non-educated	**Total = 250; n (%)**		
- 1st to 3rd quartile (< 595375 CFA /year)	102 (82.3%)	85 (67.5%)	
- 4th quartile (> 595375 CFA /year)	22 (17.7%)	41 (32.5%)	0.007

Table 8 - Logistic regression model: vaccination status and predicting factors.

	B	Significance level	O.R (CI for O.R 95.0%)
Variables			
Father's religion (non Muslim)	0.595	0.019	1.813 (1.102-2.985)
Economic status (4th quartile)	0.742	0.006	2.100 (1.242-3.554)
Availability of vaccination record card (Yes)	0.868	0.001	2.381 (1.436-3.948)
Perception of communication problems (Yes)	-0.775	0.002	0.461 (0.283-0.750)

Discussion

The complete immunization coverage rate (50.2%) remains low in Nouna district with many children reaching their first birthday without any contact with immunization services. Our findings, however, show a significant improvement from the preceding year's rate of 31.5%, obtained from the census of the district [22]. These findings require recognition of the limitations of the study and determination of the relevance of the results.

Knowledge, vaccination documents and importance of communication in immunization uptake

The relevance of the findings could be reduced if the relationship between immunization and the availability of vaccination record documents was related to our data collection procedures. Thus this finding requires further discussion. The relationship between immunization and the availability of vaccination record documents suggests three interpretations. The first is recall bias; the eligible age

group for the study included children who had already left the immunization program. Accurate recall by parents of events that took place almost a year before may, in some cases, be compromised. Challenging this hypothesis, however, is the fact that our analysis shows that the association was only significant in low economic groups and in rural areas. Additionally, of the 26.7% of those with no vaccination document, 2.5% claimed their child got no vaccine while 17.0% had no documentation, but were, in fact, completely vaccinated following appropriate mothers reporting [46,47]. The influence of not having a document on reporting, therefore, appears to be negligible.

A second interpretation, and important consideration, is that the children of parents who lost or could not afford immunization documents are not accepted at vaccination sessions. In many rural areas health workers do not vaccinate children who do not have vaccination cards. Some analyses of the anthropological study that was also carried out by CRSN as part of this operational research grant [28] show that mothers who lose their vaccination booklets or bring damaged documents to immunization sessions feel humiliated by health personnel. Vaccination workers complain they cannot interrupt the vaccination session in order to help mothers recall their children's vaccination history.

Our third interpretation is that economic conditions affect the ability to afford and keep immunization record documents in good condition.

More than half of the respondents had an accurate idea about the objectives of vaccination; about 60% of the respondents know that immunization is to prevent disease. Referring to the lower limit of the confidence interval (55.3–64.1) of this estimate, however, we suggest the urgent need for better information for at least 45% of the population. While people recognize that vaccination is for the health of their children, more detailed knowledge about immunization might be required. UNICEF, for example, states that "It is essential that all parents know why, when, where and how many times the child should be immunized. Parents also need to know that it is safe to immunize their child even if the child has an illness or a disability or is suffering from malnutrition" [20]. Reinforcing knowledge about the goal of immunization is crucial, exemplified in our findings by a significantly higher rate of complete immunization coverage when non-educated parents understand the preventive goals of vaccination ($p = 0.03$; Table 3).

Knowledge about child preventable diseases reflects an understanding of the immunization goals. Apart from poliomyelitis, which is understood by more than half of respondents, other preventable diseases remain largely ignored. Knowledge about the immunization program is proportionate to the effort the health system deploys for communication and promotion of awareness. Diseases that are addressed by specific awareness and campaign programs, such as is done for poliomyelitis, are better known because of their extensive coverage in the media.

The vast amount of respondents who wrongly named malaria as an EPI preventable disease is also important. As reported elsewhere [33], it seemed unacceptable for a frequent and disabling disease like malaria not to be taken into account by EPI. Many other diseases or symptoms considered as preventable, such as cholera or headaches, are not within the mandate of EPI. If participation in immunization is dependent on the expectation that all diseases and symptoms will be controlled, the trust and confidence of those uninformed participants who suffer – after being inoculated – from diseases with similar symptoms that were not part of the vaccination regimen will be lost. The EPI in Burkina Faso has been extended to Hepatitis B, and meningitis from *hemophilius influenzae* following our study period. Extending EPI to these new diseases offers considerable improvement that may also increase the populations' participation in the program if they are well informed.

Our results show that perception of communication problems by parents halves the chance (0.46 times) of a child being completely vaccinated. We suggest, along with others, that better communication, including more appropriate interaction between parents and health workers is needed [9,31]. Communication on immunization in the Nouna district is rarely comprehensive; it is generally marginal, partial and sporadic. Campaigns on specific diseases like poliomyelitis and meningitis overshadow the whole EPI. In addition, health workers insist they are not able to engage in communication/health education during immunization sessions; they are overloaded with the responsibilities of registering children, filing records, managing and administrating vaccines. New strategies are needed to make communication an integral part (not a marginal component) of the immunization program in order to achieve the target proposed by UNICEF [20]. This may require consideration from decision makers regarding the actual human resources and service needs of the health centres, which might be the first step towards the essential recognition of immunization as a public health priority in Burkina Faso.

Importance of education literacy and religion

Our analysis revealed the considerable influence of social factors contributing to vaccination status. Parents who attended school (in the urban area) and mother's attendance in literacy classes (in rural areas) were related to vaccination status. The influence of education confirms findings from previous studies [18]. Little is known, how-

ever, about the relationship between parents' attendance in literacy classes and immunization status of the child. This suggests the need to assess the relationship that might be built between immunization communication strategies and current strategies used in literacy training when designing immunization coverage improvement interventions. Increasing the level of adult literacy or incorporating vaccination awareness in literacy programs may improve the understanding of rural communities on health issues such as immunization.

Another social determinant assessed in this study was religious affiliation. Particular Muslim factions shaped some communities' relation to immunization questions [14,15]. In our study, children of Muslim families (controlling for economic status) have significantly lower rates of complete immunization coverage in rural areas. Non-Muslims had almost twice the probability of being in the completely vaccinated group. Our study did not account for the role of Muslim opposition to immunization that played out in Nigeria (where immunization was presented by some Islamic factions as an instrument threatening the well-being of Muslim communities) [14,15]. We suggest, however, that in Nouna the problem is more related to access to information. A previous study in the area reported that women who attended Koranic School were less likely to participate in HIV counselling [45]. In Nouna district, women are responsible for going with the child to the vaccinating site. In some Muslim communities, external informants have only limited and controlled access to women. In addition, in the two Muslim dominant ethnic groups (Marka and Mossi), women are said to be less "free" than in the Christian and the animist dominant ethnic group (Bwaba) [44]. Our result corroborates previous findings as to the sensitivity of the relationship between immunization uptake and religious matters [12,17]. The problem is not limited to Muslims, as researchers [17] have also noted the low immunization coverage rates among orthodox Protestant inhabitants in the Netherlands. In Nouna district, we have previously documented the influence of the Catholic church on AIDS prevention campaigns, particularly its untactful disapprobation of condom use [44]. Combining these findings, it appears that the complex relationships between religious matters and health outcomes must be questioned more deeply. These results suggest that intervention on the issue can neither neglect religious considerations nor the particular learning environments of specific groups. Health intervention planners should integrate both health promotion and adult literacy into their activities; they must also consider the distribution and involvement of religious groups.

Distance and location

Our study put an emphasis on location and geographic determinants, and we can draw three conclusions from these factors. First, unlike other findings [23-25], there is no intra-village distance-based disparity as to children's vaccination status. Those living at village boundaries have the same probability of being fully vaccinated as those living near the selected fixed vaccination sites of the village. The average distance separating the households of completely vaccinated children and those separating others from the vaccination points are not statistically significant. However, the result is strategically significant as it argues in favour of the current vaccination strategy in Nouna district. In each village, one, two or three vaccination sites are selected with the participation of the community; these places change according to the season. We can also postulate from this result that the withdrawal of some of these sites, which is planned by some health teams, may influence vaccination coverage in those areas. The second conclusion related to location and geographic factors is that after controlling for urban areas, our analysis suggests that children of the villages hosting a health centre have better immunization coverage rates compared to surrounding villages, but there is no difference between villages outside the site of the health centres. Equal effort is given to all outreach villages. The third conclusion suggests that children born in health facilities in the villages have a better vaccination coverage rate compared to those born at health facilities in the town of Nouna. This may show less effective targeting of services in the larger, more heterogeneous communities. Unlike many cases where urban areas are better off with respect to immunization coverage, living in Nouna does not warrant better immunization coverage compared to rural areas. Discussions with some health workers suggest that in the urban area of Nouna, some nurses regard immunization as a low status activity. There is a need for district managers to design specific interventions for towns in similar conditions so that the view that immunization is an important health intervention can be restored at the health worker level.

Economy and living conditions

Like previous studies [19], our findings suggest there is a difference in vaccination coverage related to the economic conditions of households. In rural areas, children in the highest economic quartile have a better immunization coverage rate and a greater probability (2.1 times) of being vaccinated. However, we should not reduce the ability to pay to an incentive to immunize. The influence of economic factors remains more complex than ability to pay, as immunization services are free of charge in Burkina Faso. At the same time, it is also difficult to claim that all health centres are following this free of charge requirement. Some of the reasons given by mothers for not participating in immunization sessions are that they did not have the money required (suggesting their belief that money is sometimes being demanded of them). The

indirect influence of economic factors on immunization at household levels is a more obvious explanation. When the household is experiencing food and resource shortages, participating in a session becomes a matter of lesser priority. A man who participated in our discussion sessions gave a clear explanation:

"What I add...it's the problem we usually face during rainy season. In the household we often face difficulties, i e. some crisis periods, when there is no food to eat. When we spend a bad night because we had no more supplies, each may try (in the morning) *to find something for the children. So you are all in a hurry; the husband will go on his way and the wife will try to find some shea nuts* (in the bush). *Under the pressure of food shortage, as parents, you don't want children to wakeup and find you without a solution for their hunger; they will look so pitiful. These problems can be the reason for not respecting the appointment with the vaccination team."* A Young father in Toni village.

It may be difficult for decision makers to control the indirect influence of economic factors on immunization uptake. However, there remains a need to identify all the interactions between the health system and the communities that require money. Thus, large-scale communication about the free services and careful monitoring of vaccination procedures should be undertaken to clarify the issue at the community level.

Final considerations

The result of the regression model reported a Nagelkerke R2 of 0.186; although this may explain only 18.6% of the variance of immunization status in rural areas, we suggest this is an important contribution. Given the equal distribution of vaccination outcome (50.2%), the variance is at its maximum and explaining 18% of that variance is critical. In addition, a child's immunization uptake depends on many other factors not related to communities; this also needs to be taken into account when explaining the overall variance of complete immunization outcome. Finally, the overall validity of the regression is proven by a non-significant Hosmer-Lemeshow test of goodness of fit (khi2 = 5.516, df = 7; significance = 0.597) [48,49].

Although research from the health services perspective would have suggested a different explanation of the variance, we can still conclude from this discussion that the result of the study is relevant and can orient intervention.

The results of the regression model distinguished two groups of factors influencing immunization coverage. Two factors are related to households (economic conditions and religion) and two other factors related to the interaction between households and the health centre (communication and availability of vaccination record document). Our research explored the question from a population perspective. Our results suggest that considering both communities and health services is important in designing interventions. An intervention targeting only the community or only the health workers will not resolve the low immunization coverage rate. There is a need for an integrated approach at both the community and the health service level.

Based on our results and analysis, we can postulate that the intervention planned by CRSN and the Nouna health district should have at least two principal components. One should target the community and the other one should be at the level of the health service delivery. Health workers must be trained to fully integrate communication into their activities and appropriate communication frameworks should be established between health workers and communities. Designing and adapting culturally appropriate sensitization tools that incorporate the use of pictures would probably address issues related to illiteracy. It is important that information about the immunization program be as complete as possible, that information be made available in all public places and that it be relevant to all residents. Collaboration with religious and community leaders is also essential to ensure broad dissemination of immunization messages. To reinforce the importance of immunization at both community and health workers levels, trainings planned as part of the intervention are expected to inform all participants about the real cost incurred by the government and its partners for immunization. Community members, however, should be well informed that, despite this cost incurred by the government, immunization is free of charge; this will allow them to recognize the effort made to bring immunization to their doors while at the same time making them more cautious of attempts to make them pay to immunize their children.

Study limitations

A key issue faced by immunization researchers in areas with high illiteracy rates is managing respondents' recall bias, and information bias when using only vaccination cards. Studies show that mothers' responses are accurate and provide generally adequate information even if they are said to underreport immunization uptakes [46,47]. The rate for immunization coverage we obtained in this study is extremely high compared to results of the national census of the previous year. Concern about the under reportage of immunization coverage due to poor recall has been put to rest. What this study cannot rule out is the possibility of over reportage due to poor recall. We show, however, a strong association between complete immunization and the presence of immunization booklets. This study cannot, on its own, provide an explanation for the increase in complete immunization

coverage rate nor can it completely account for the role of the vaccination card in these results. The anthropological study mentioned earlier [28] and which had a special focus on the immunization record cards provides a fuller description to that end.

It was not our original intention to compare urban and rural areas and therefore the sampling procedure did not take this into account. Determining the number of children proportionally resulted in having a relatively fewer number of children in the urban area. The result is that the regression model could not accommodate locality (urban/rural) for categories and use at the same time all the eight variables having a significant relationship with the outcome. Two variables distribution in the urban area could not satisfy the rule of minimum ratio of 10 to 1 (having a sample size with at least 10 cases for 1 variable in the regression) [49]. As such, extending the interpretation of the regression analysis to the urban area requires caution. It is important to note, however, that the analysis of six variables in the regression (not presented here) produced the same result as the one presented in this report.

Another study limitation is the procedure used to determine economic status. Determining economic status through a single monetary value estimated from agricultural production, animals and poultry, salaries and trade revenues is rather exclusive. Equipment, housing conditions and others properties (also collected during the study) could have contributed to the reliability and validity of socio-economic status. Additionally, the principal economic activity was the main source of information, excluding the secondary activities of other members of the household. Nonetheless, our estimate of economic conditions is associated with education and knowledge variables, providing external validity.

Conclusions

Beyond reaching the communities, the primary goal of EPI activities should be to get people to better understand what vaccination is about and what is at stake. Poor communication around immunization and inadequate knowledge about its objectives and the importance of the immunization booklet seem to account for the low immunization coverage in our study area. Comprehensive information and communication on immunization (instead of relying on sporadic single disease specific messages like those of poliomyelitis and other epidemics) may improve understanding of immunization for many communities; both strategies must be used complementarily. The question of whether this communication work is feasible for small health teams needs to be addressed.

Social factors like education are always important with regards to access and health seeking behaviours, including immunization uptake. In the context of a high level of illiteracy, as occurs in the Nouna Health District, taking note of adult literacy and accommodating it through health promotion mechanisms would be an appropriate approach to improving the immunization coverage rate. A clear difference among certain religious groups was found in immunization coverage. We suspect that unequal access to information is the likely cause of this difference. Designing local interventions should therefore take into account complex cultural specificities to access, such as religion.

The goal of improved access is currently also hampered by poor household economic conditions. Health intervention planners have limited influence on economic conditions of the households. However, considering critical economic periods and conditions in the implementation of interventions may help solve this limitation.

As to geographic factors, the incorporation of vaccination strategies using local vaccination sites to target uptake in remote areas of the district provides better opportunity to access vaccination services for children. Consequently, rural areas are in a better position to achieve improved immunization coverage. Different approaches are clearly needed for the urban area. Urban health units need to make additional efforts to better address the needs of a more heterogeneous range of people living in urban centres, starting with children born in their health facilities.

Our findings suggest that improving immunization coverage requires considering contextual factors related to individual resources and communities but also those related to the interaction between communities and the health system. Determining the responsibility and capability of each partner is a key to designing contextually relevant health interventions.

Ethical issues

This research was accepted by the local ethical committee (Comité Local d'Éthique). Interviews were performed after explaining the objective of the study and obtaining the consent of the respondents. Security and confidentiality of the data is preserved using the CRSN procedures. The informants are rendered anonymous by using an alphanumerical coding system to identify the compound, the household and the members.

List of abbreviations used

WHO – World Health Organization; EPI – Expanded Program on Immunization; IDRC – International Development Research Centre; CIII2 – Canadian International Immunization Initiative Phase 2; CRSN – Centre de Recherche en Santé de Nouna; CMA – Centre

de Santé avec Antenne Chirurgicale; CSPS – Centre de Santé et Promotion Sociale; DSS – Demographic Surveillance System; GPS – Global Positioning System; ATRA – Average Theoretical Range of Action.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

AS participated in the design of the study, carried out the field studies, analyzed the data and drafted the manuscript. SS carried out the GPS and the field measurements of distances for the study. BK participated in the coordination of the study, the critical revision and the interpretations of the results. MD participated to the critical revision and interpretation of findings. JG participated to critical revision, interpretation of the findings. GB conceived of the study, and participated in its design and coordination and helped to draft the manuscript. All authors read and approved the final manuscript.

Additional material

Additional file 1

Abstract in French.
Available from:
http://www.biomedcentral.com/content/supplementary/1472-698X-9-S1-S10-S1.doc

Acknowledgements

This work was carried out with the aid of a grant from the International Development Research Centre (IDRC), Ottawa, Canada, as part of the Canadian International Immunization Initiative Phase 2 (CIII2). This initiative is a project of the Global Health Research Initiative (GHRI). The authors would like to thank the team of the Centre de Recherche en Santé de Nouna (CRSN) and to the local communities. Many thanks to all co-investigators who participated to the ETUVAC study: Gilles Bibeau (PI), Bocar Kouyaté (PI), Aboubakary Sanou, Marylène Dugas, Séraphin Simboro, Maurice Ye, Jean-Claude Robert Lucien Kargougou, and support teams Casimir Ouédraogo, Alphonse Zakané. Special thought go to the coordinator of this study, Florent Somé, who tragically died in August 2005.

This article is published as part of *BMC International Health and Human Rights* Volume 9 Supplement 1, 2009: The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants. The full contents of the supplement are available online at http://www.biomedcentral.com/1472-698X/9?issue=S1.

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The role of supportive supervision on immunization program outcome – a randomized field trial from Georgia

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from The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants

Published: 14 October 2009

BMC International Health and Human Rights 2009, **9**(Suppl 1):S11 doi:10.1186/1472-698X-9-S1-S11

This article is available from: http://www.biomedcentral.com/1472-698X/9/S1/S11

Abstract

Background: One of the most common barriers to improving immunization coverage rates is human resources and its management. In the Republic of Georgia, a country where widespread health care reforms have taken place over the last decade, an intervention was recently implemented to strengthen performance of immunization programs. A range of measures were taken to ensure that immunization managers carry out their activities effectively through direct, personal contact on a regular basis to guide, support and assist designated health care facility staff to become more competent in their immunization work. The aim of this study was to document the effects of "supportive" supervision on the performance of the immunization program at the district(s) level in Georgia.

Methods: A pre-post experimental research design is used for the quantitative evaluation. Data come from baseline and follow-up surveys of health care providers and immunization managers in 15 intervention and 15 control districts. These data were supplemented by focus group discussions amongst Centre of Public Health and health facility staff.

Results: The results of the study suggest that the intervention package resulted in a number of expected improvements. Among immunization managers, the intervention independently contributed to improved knowledge of supportive supervision, and helped remove self-perceived barriers to supportive supervision such as availability of resources to supervisors, lack of a clear format for providing supportive supervision, and lack of recognition among providers of the importance of supportive supervision. The intervention independently contributed to relative improvements in district-level service delivery outcomes such as vaccine wastage factors and the

DPT-3 immunization coverage rate. The clear positive improvement in all service delivery outcomes across both the intervention and control districts can be attributed to an overall improvement in the Georgian population's access to health care.

Conclusions: Provider-based interventions such as supportive supervision can have independent positive effects on immunization program indicators. Thus, it is recommended to implement supportive supervision within the framework of national immunization programs in Georgia and other countries in transition with similar institutional arrangements for health services organization.

Abstract in Russian: See the full article online for a translation of this abstract in Russian.

Abstract in Russian

See Additional file 1 for a translation of the abstract to this article in Russian.

Background

A lack of experienced and quality human resources can easily jeopardize the success of any health program, including an immunization program. Alongside many variables that can cause poor coverage, such as inadequate financing, poor vaccine quality, poor vaccination practices, and weak health care systems [1], one of the most common barriers to improving immunization coverage rates is human resources and its management [2].

Effective human resource management has been defined as fundamental principle of quality health system performance [3]. To meet patients' needs in terms of provision of quality health services, the role of the workforce should be clearly defined, and it should be well deployed and organized [4]. In addition, a workforce must be motivated and appropriately skilled to do the job well [3].

Following independence, Georgia initiated widespread health care reforms in 1995. The reforms' key components included decentralization and reforming health care financing [5]. Recent reports suggest that the reforms conceived in 1995 were neither comprehensive enough nor well implemented [6]. The decentralization of health care financing and service supply responsibilities to the municipal level caused fragmentation and the delegation of powers was unclear and created unclear lines of responsibility [6]. These reforms affected much of the health care sector, including the National Immunization Program (NIP). Although Georgia has scaled up its vaccination coverage since 1995, coverage rates remained poor over the course of the reforms. For example, estimates in 2003 obtained from Georgia's new Immunization Management Information System (MIS) report coverage rates of 75% for DPT-3 and Polio-3, 48% for Hepatitis B-3 and 82% for Measles-1 [7]. While recognizing the role of many factors that can influence low coverage rates, an important factor which has caused a negative effect has been weak human resource management within the NIP, namely weak organizational structure and processes and a lack of knowledge and skills in management and supervision, especially at peripheral levels [7].

Overall, there is a limited amount of peer-reviewed medical literature addressing supportive supervision. Supportive supervision is defined here as a range of measures to ensure that personnel carry out their activities effectively through direct, personal contact on a regular basis to guide, support and assist designated staff to become more competent in their work. Two studies showed that nursing performance can benefit from supportive management and supervision [8,9]. The intervention was also shown to increase the health services efficiency (in terms of best use of resources) and equity (in terms of health care provision according to people's needs), achieving a substantial reduction of the burden of disease at reasonable cost [10].

Supervision of primary health care providers was tested through a randomized trial in Zimbabwe, which showed that, following supervision, overall drug management improved significantly compared with control and comparison groups. The study also showed that supervision can have a positive effect on improving performance in areas other than those supervised. Allocating resources to supervision is likely to result in improved performance of health workers with regard to the rational use of essential drugs, resulting in improved efficiency and effectiveness [11].

In developing countries, staff working in peripheral facilities where supervision is problematic deliver most primary health care services. A controlled field trial conducted in the Philippines examined whether systematic supervision using an objective set of indicators could improve health worker performance. In the intervention facilities, a correlation was found between frequency of supervision and improvements in performance. The authors concluded that systematic supervision using clearly defined and quantifiable indicators can improve service delivery considerably, at a modest cost [12]. One

particular study documented that intense supervision led to high provider performance in systematic influenza and pneumococcal vaccination in a busy public emergency department setting despite initial resistance and extreme variation in individual performance [13].

Evidence obtained from the aforementioned studies suggest that promoting supportive supervision among managers of immunization programs may have a beneficial effect in transition countries (e.g. Georgia), where these programs are often impeded by factors such as poorly trained personnel and limited financial resources for health care workers.

Thus, the objective of the study was to document the effects of "supportive" supervision on the performance of the immunization program at the district(s) level in Georgia.

Methods

EPI service organization in the country

In Georgia there are 67 districts, and each district has a population of around 40,000-50,000 living in a district centre (small town) and surrounding 15-30 villages/communities. This unit (i.e. district) was chosen as the cluster unit of randomization. Normally, health workers working at district polyclinics (there is one such facility per district centre) and village ambulatories (usually one ambulatory per village) provide primary health care (including immunization) to district populations. The number of personnel available at primary health centres is determined by the size of the target population. Supervision of health workers for immunization work is done by a district immunization manager working out of the district Centre of Public Health (CPH). The immunization manager's job is to supervise, monitor and evaluate immunization programs, including vaccine supply/cold chain and operating district level immunization MIS. In every district, there is a CPH, which reports to the National Centre for Disease Control and Public Health, including on immunization work carried out within the framework of the NIP. In intervention districts, there were 194 health facilities and 778 primary healthcare workers (373 primary care doctors, and 405 primary care nurses) responsible for immunization, which were supervised by 31 immunization managers working in 15 district CPH.

Design

The effectiveness of the intervention package was assessed through a pre-post experimental research design, supplemented with the qualitative data from focus group discussions (FGDs), where possible.

Stratified cluster randomization was used to select the 30 cluster units out of the nation's 67 districts and allocate them into the two study groups (intervention and control), yielding two allocation sequences of 15 clusters each. Baseline covariates used for stratification were immunization program performance indicators (DPT3 and HEPB3 coverage) for 2003. Intervention and control districts were assigned by random allocation with a table of random numbers.

A cohort of individuals responsible for immunization program management within district CPH and health care providers responsible for provision of immunization services to populations within the 15 districts selected served as the intervention group. Immunization program managers and providers within 15 control districts were selected to help validate any resulting changes in individual level outcome indicators within the intervention group. Measurements were assessed at the baseline and at the end of the one-year intervention on an individual level. Given that immunization managers supervise health workers only within their districts, and similarly health workers provide immunization services to target population residing in communities within the same district, the risk of contamination of the control group with the intervention is negligible. Use of smaller units (e.g. village) would have posed a higher risk of contamination of intervention activities in control clusters.

The Institutional Review Boards of Tbilisi State Medical University and the Office of Research Ethics, University of Toronto approved the protocol of the study. All participants gave informed written consent.

Intervention

The overall intervention evaluated in this study consisted of a package of activities, which included development of supportive supervision guidelines for district immunization managers, district-level training in continuous supportive supervision, monitoring and evaluation of performance, and funding for district CPH to carry out the package of interventions (travel and communication costs). Supportive supervision, which was the focal point of the package of interventions, was based on a) introducing updated job descriptions with documented lines of supervision, b) improving communication lines and skills, and c) introducing guidelines and tools for supervision, performance review and monitoring, and evidence-based action planning, all of which help health workers to improve immunization service delivery.

Guidelines and tools for supervision included detailed instructions for conducting supervision, namely, sequence for conducting supervision meeting, checklist for supervisory visit, self assessment for providers, work planning action sheets, do's and don'ts of supervision, supervisor competencies, tips on delegation, tips on giving feedback, tips on resolving conflict, and tips on

conducting difficult conversations. Every immunization manager from the intervention group was visiting each subordinated health facility at least once in a month.

Full-scale implementation of the project operations (supportive supervision) started in January 2005. Immunization managers from 15 intervention districts were trained to apply supportive supervision guidelines in practice. The subsequent 12 months involved extensive monitoring and on-the-job training of immunization managers and supervisors to improve supervision practices to help providers to solve problems related to immunization.

Participants and sample size

Assuming a proportion of PHC providers having job descriptions of 44.4% in the control group, we calculated that a sample size of 300 PHC providers in each study group would be sufficient to detect at least 10% higher proportion of providers with updated job descriptions in the intervention group with 90% power and an unadjusted type-1 error of 5%. We also considered a potential non-response rate of 30% for both groups. The sample size was calculated for the comparison of two proportions. As for the number of cluster units, i.e. districts, we had to consider the budgetary limitations of the research project taking into account the considerable cost of implementing the intervention (funding for district CPH to carry out the package of intervention including travel and communication costs).

PHC providers were selected randomly to complete self-administered questionnaires at baseline and at follow up, thus two independent random samples were assembled. Baseline data were collected from 197 PHC providers in intervention districts and 195 PHC providers in control districts (overall response rate 65.3%). At follow-up, the number of respondents in intervention districts was 282 and 239 in control districts (overall response rate 86.8%).

In total, 15 immunization managers were selected randomly in both intervention and control group (one manager per district CPH) to complete the self-administered questionnaire at baseline (pre test). Out of these, 14 immunization managers from intervention districts and 12 immunization managers from control districts completed the questionnaires. This was followed by the training on supportive supervision attended by all 31 immunization managers working at intervention district CPH. At the follow up, self-administered post-test questionnaires were completed by all 31 immunization managers from intervention districts and by 15 immunization managers from control districts. Out of all 46 individuals that participated in at least one round, 26 immunization managers (14 from intervention districts and 12 from control districts) participated in both rounds of data collection.

Data collection and management

Quantitative data

Outcome measures were ascertained using a self-administered questionnaire to a cohort of CPH immunization managers within intervention and control districts at baseline and again at follow-up. The questionnaire consisted of Likert scale, yes/no and open-ended questions. The questionnaire was pre-tested prior to data collection. Collected data were managed by MS Office Access database format.

Qualitative data

The survey was complemented by FGDs that were conducted pre- and post-intervention in December 2004 and February 2006 within intervention districts. In total, the following eight groups of individuals from intervention CPH offices and health care facilities were included in the FGDs:

District CPH office immunization managers (baseline and follow up)

District CPH office directors (baseline and follow up)

Health care facility manager (baseline and follow up)

Health provider (baseline and follow up)

For each group, the size of the group ranged from five to seven individuals. Focus group guides were developed separately for CPH staff and for health care providers. Participants were mostly the same individuals for the two rounds. The length of the discussion sessions averaged between two and two and a half hours for CPH staff and between one and one and a half hours for the facility staff. Two researchers conducted each focus group discussion and were joined by a moderator who led the discussion and a facilitator who handled logistics and took notes. The facilitator recorded the participant demographics, the time, duration, and location. As far as possible, the discussions took place in a setting where the session was not interrupted. Each of the FGDs were audiotaped and transcribed. The research team created a coding scheme using broad categories to organize the data, such as the overall performance of immunization program, the change in work environment, the barriers to supportive supervision, and perceived value of supportive supervision. Using these predefined codes, information was organized and displayed.

Outcome indicators

The following indicators were measured for study purposes:

- District level service delivery outcome indicators that helped to measure effectiveness of the intervention

package pertained to: 1) immunization coverage; 2) rate of contraindications to vaccination (as diagnosed by health care providers); 3) rate of refusals to vaccination (as declared by parents); and 4) vaccine wastage.

- Individual-level outcome indicators pertained to: 1) perceived quality of organization of work at their CPH office/facility; 2) knowledge of how to carry out supportive supervision; 3) motivation/need to provide/receive supportive supervision; and 4) perceived barriers to implementing supportive supervision.

Five-point Likert scale questions, with responses ranging from strongly disagree to strongly agree, were used to ascertain information for constructing individual-level baseline and outcome indicators. The decision to focus on perceptions and motivation of district CPH and health care facility staff was based on the premise that improvements in motivation to practice supportive supervision and the knowledge and attitude towards supportive supervision are necessary to improve the performance of immunization program [14].

A univariate analysis was used to compare outcomes pre/post-test. A multivariate regression model was used to account for potential confounders. Qualitative data were analyzed using standard qualitative analysis methods [15].

Statistical methods

All statistical analyses were conducted using SPSS 12.0©. Differences between groups for categorical variables were assessed using Chi-square, and for continuous variables – analysis of variance (ANOVA). Differences between pre and post-test for continuous variables within the same group were assessed by paired-sample t-test. For all tests, a two-sided P-value <0.05 was considered statistically significant.

To delineate an independent role of the intervention in improving individual level outcomes among immunization managers, we conducted multivariate analysis. Namely, the analysis of individual Likert scale outcomes was modelled using the Generalized Linear Model (GLM) for repeated measures. Indicators pertaining to individual level outcomes within intervention and control groups were measured among the same individuals at baseline and again one year later at follow-up after the implementation of the intervention. Age and years of experience in the current job were included to control for individual-level confounders. Geographic area was included to control for a number of differences that may exist between big cities and small towns/ rural areas, hypothesized to include such potential confounders as governmental funding, access to health care, difficulties with transportation of immunization managers, etc. The interaction term "treatment group* geographic area" was also included in the model.

The independent role of the intervention in improving district level service delivery outcomes was assessed by comparing the treatment groups in terms of the changes from baseline, (i.e. magnitude of these changes ("change magnitude")). The difference between groups for the "change magnitude" was assessed using ANOVA.

Results

Demographic and employment characteristics

Demographic and employment characteristics were similar among CPH staff respondents in the intervention and control groups, both at baseline and follow up (Table 1). The majority of both intervention and control respondents were females, their mean age was slightly lower in the intervention districts compared with control districts, though with no statistical difference between groups. There was slight difference in the mean years in current job, again with no statistical difference between groups.

The only statistically significant difference was that health providers in the control districts appeared to be older at post-test (45.71 *vs.* 43.54 years, ANOVA, P=0.011), and have longer experience in working in the current profession (at pre test: 20.98 *vs.* 18.70 years, ANOVA, P=0.027; at post test: 19.48 *vs.* 17.57 years, ANOVA, P=0.027) (Table 1).

Evaluation results

Results of the survey demonstrate that the intervention package was implemented as intended within the 15 intervention districts. Table 2 shows that all immunization managers in intervention districts received supportive supervision guidelines. All but one supervisor (96.8%) were trained prior to the intervention on how to use supervision guidelines, execute performance reviews, and monitor achievements. In the control districts, none of the supervisors were trained in supportive supervision or received the supervisory guidelines. Supervisors in intervention districts visited subordinate health care facilities on average once a month, whereas supervisory visits in the control districts were at approximately once every two and a half months (ANOVA, p=0.000). At baseline, the proportion of health providers having job descriptions was higher in the intervention districts compared with control districts and this difference was statistically significant (54.5% *vs.* 44.4%, X^2, p = 0.034). However, at follow up, this difference between the two groups was more profound (84.2% *vs.* 49.8%, X^2, p = 0.000).

Table 3 presents individual level outcome indicators for both immunization managers and health providers. These indicators are calculated as mean values of Likert scale questions (1= strongly disagree, 2= disagree, 3= neither

Table 1 - Demographic and employment characteristics among immunization managers and service providers by treatment group and pre- and post-test.

Immunization managers	Treatment group	Pre-test (N=14, 12)	Post-test (N=31, 15)
1. Proportion of females	Intervention	80.0%	96.8%
	Control	80.0%	80.0%
	X^2	*P=0.674*	*P = 0.095*
2. Mean age (SD)	Intervention	41.1 (8.79)	42.3 (7.60)
	Control	44.5 (8.47)	46.9 (8.11)
	ANOVA	*P=0.290*	*P =0.068*
3. Mean years in current job (SD)	Intervention	4.1 (2.17)	5.8 (3.54)
	Control	5.5 (4.38)	7.2 (2.96)
	ANOVA	*P=0.082*	*P=0.185*
Health providers	**Treatment group**	**Pre-test (N=197, 195)**	**Post-test (N=282, 239)**
1. Proportion of females	Intervention	95.4%	93.3%
	Control	96.9%	95.0%
	X^2	*P=0.304*	*P=0.262*
2. Mean age (SD)	Intervention	44.8 (9.51)	43.5 (9.67)
	Control	46.3 (9.34)	45.7 (9.70)
	ANOVA	*P=0.112*	*P=0.011*
3. Mean years in current profession, mean (SD)	Intervention	18.7 (10.18)	17.6 (10.13)
	Control	20.9 (10.06)	19.5 (10.52)
	ANOVA	*P=0.027*	*P=0.035*

SD, standard deviation.

Table 2 - Details on implementation of intervention among immunization managers and health providers by treatment group and pre- and post-test.

Immunization managers	Treatment group	Pre-test (N=14, 12)	Post-test (N=31, 15)
1. Proportion of CPH offices receiving the supervisory guidelines to assist designated/supervisory staff to become more competent in their work	Intervention	0	100
	Control	0	0
	X^2		***P = 0.000***
2. Proportion of CPH staff/ supervisors trained how to use guidelines in supervision, performance review, and monitoring achievements	Intervention	0	96.8
	Control	0	0
	X^2		***P = 0.000***
3. Average number of supervisory visits to each subordinated health care facility per month, mean (SD)	Intervention		1.00 (0.00)
	Control		0.37 (0.33)
	ANOVA		***P = 0.000***
Health providers	**Treatment group**	**Pre-test (N=197, 195)**	**Post-test (N=282, 239)**
1. Proportion of health facility staff having job descriptions with documented lines of supervision	Intervention	54.5	84.2
	Control	44.4	49.8
	X^2	***P = 0.034***	***P = 0.000***

agree nor disagree, 4= agree, 5= strongly agree). Immunization managers in both intervention and control districts were satisfied with organization of work in their CPH at baseline and follow up. In contrast, health providers were less satisfied with organization of work in their facility, however between baseline and follow up, no significant improvement was observed. Immunization managers in both intervention and control districts felt capable of carrying out supportive supervision both at baseline and follow up, and were persistent in declaring a high professional motivation to provide supportive supervision to subordinated staff. Likert scale scores were relatively lower for financial motivation at baseline, albeit with some increase from baseline to follow up, but still with no statistically significant difference between intervention and control groups. At follow up, immunization managers in intervention districts had significantly better perceived knowledge on how to carry out supportive

Table 3 - Likert scale question on organization of work and supportive supervision among immunization managers and service providers by treatment group and pre- and post-test (values range from 5=strongly agree to 1=strongly disagree).

		Mean values and SD from Likert scale	
Immunization managers	Treatment group	Pre-test (N = 14, 12)	Post-test (N = 31,15)
1. I am satisfied with organization of work in their CPH	Intervention	3.60 (0.83)	3.87 (0.85)
	Control	3.87 (0.64)	3.60 (0.83)
	ANOVA	*P = 0.33*	*P = 0.31*
2. The overall work environment is good in our CPH	Intervention	3.47 (0.99)	3.58 (0.92)
	Control	3.20 (1.01)	3.40 (0.83)
	ANOVA	*P = 0.47*	*P = 0.52*
3. Feel capable of carrying out supportive supervision	Intervention	4.13 (0.35)	4.52 (0.51)
	Control	3.87 (0.64)	4.53 (0.52)
	ANOVA	*P = 0.17*	*P = 0.92*
4. Possess sufficient knowledge to carry out supportive supervision	Intervention	3.00 (0.75)	4.45 (0.62)
	Control	3.20 (0.77)	3.33 (1.05)
	ANOVA	*P = 0.48*	***P = 0.000***
5. Are professionally motivated to provide supportive supervision to subordinated staff on a regular basis	Intervention	4.20 (0.41)	4.45 (0.51)
	Control	4.13 (0.35)	4.27 (0.46)
	ANOVA	*P = 0.64*	*P = 0.24*
6. Are financially motivated to provide supportive supervision to subordinated staff on a regular basis	Intervention	2.40 (0.63)	3.32 (1.08)
	Control	2.27 (0.70)	3.47 (1.30)
	ANOVA	*P = 0.59*	*P = 0.69*
Immunization service providers	Treatment group	Pre-test (N = 197, 195)	Post-test (N=282, 239)
1. Organization of work in their facility is not good	Intervention	2.56 (0.94)	2.24 (0.86)
	Control	2.38 (0.96)	2.33 (0.94)
	ANOVA	*P = 0.058*	*P = 0.27*
2. Feel they need supervision from immunization managers	Intervention	3.73 (0.90)	3.58 (0.83)
	Control	3.40 (0.98)	3.41 (0.95)
	ANOVA	***P = 0.01***	***P = 0.033***

supervision compared with immunization managers in control districts, and health providers in intervention districts were more confident that they were in need in supervision from immunization managers as compared with providers from control districts.

Table 4 suggests that in intervention districts a number of barriers to implementing supportive supervision, as perceived by immunization managers, were removed or weakened over the course of intervention. These included: the "existence of a clear format for providing supportive supervision", "providers' recognition of the importance of supportive supervision", "the availability of resources to conduct supportive supervision", and "immunization managers' knowledge of how to conduct supportive supervision". A "lack of penalties for supervisors if providers' performance is low" was recognized as a barrier by immunization managers in both intervention and control districts and this perception did not change from baseline to follow up. A "lack of time to supervise facilities", and particularly a "lack of willingness to conduct supportive supervision" were not considered as barriers at both time points. Immunization managers in intervention districts, as compared with managers in control districts, have changed their perception that they are not paid enough to do supportive supervision, but the difference between the groups did not reach statistical significance at follow up. Health providers in both intervention and control districts did not agree on the lack of effective management and support from the upper level; however, respective Likert scale scores were significantly lower among providers in intervention districts as compared with that in providers from control districts.

Based on the results of multivariate analysis, the effect of the intervention among immunization managers was found to have independently contributed to the improvement of self-perceived knowledge to carry out supportive supervision (p =0.034), as the mean score for this question increased by 1.09 among the intervention group while decreased by 0.14 among the control group pre and post-test (Table 5). The intervention also had a significant impact on decreasing the number of self-perceived barriers to supportive supervision including

Table 4 - Likert scale question on main barriers to implementing supportive supervision among immunization managers and providers by treatment group and pre- and post-test (from 5=strongly agree to 1=strongly disagree).

		Mean values and SD from Likert scale	
Immunization managers	Treatment group	Pre-test (N = 14, 12)	Post-test (N = 31,15)
1. There is no clear format for providing supportive supervision to facilities and providers responsible for immunization	Intervention	3.87 (0.64)	2.21 (0.82)
	Control	3.73 (0.59)	3.27 (0.88)
	ANOVA	*P = 0.56*	***P = 0.000***
2. Providers do not recognize the importance of receiving supportive supervision	Intervention	3.53 (0.99)	2.14 (0.74)
	Control	3.00 (0.85)	2.87 (0.92)
	ANOVA	*P = 0.12*	***P = 0.007***
.3 There is no penalty for supervisors if providers performance is low	Intervention	4.27 (0.46)	3.76 (0.99)
	Control	4.07 (0.46)	4.07 (0.46)
	ANOVA	*P = 0.24*	*P = 0.26*
4. Immunization managers do not have the time to supervise facilities/ providers rendering immunization services to population	Intervention	2.27 (1.03)	2.28 (0.92)
	Control	2.40 (0.74)	2.33 (1.05)
	ANOVA	*P = 0.69*	*P = 0.85*
5. Immunization managers do not have resources to supervise facilities/ providers rendering immunization services to population	Intervention	3.93 (0.88)	2.90 (1.05)
	Control	3.93 (0.46)	3.87 (0.83)
	ANOVA	*P = 1.00*	***P = 0.003***
6. Immunization managers do not know how to do supportive supervision	Intervention	3.67 (0.62)	1.83 (0.54)
	Control	3.80 (0.56)	3.87 (0.73)
	ANOVA	*P =0.54*	***P = 0.000***
7. Immunization managers do not have the willingness to do supportive supervision	Intervention	1.93 (0.46)	1.79 (0.49)
	Control	2.00 (0.00)	1.80 (0.68)
	ANOVA	*P = 0.58*	*P = 0.97*
8. Immunization managers are not paid enough to do supportive supervision	Intervention	3.87 (0.74)	2.66 (1.05)
	Control	3.93 (0.79)	3.20 (0.77)
	ANOVA	*P = 0.82*	*P = 0.083*
Health providers	Treatment group	Pre-test (N = 197, 195)	Post-test (N=282, 239)
1. There is no effective management and support from the upper level	Intervention	2.55 (1.02)	2.15 (0.77)
	Control	2.56 (0.98)	2.37 (0.89)
	ANOVA	*P = 0.94*	***P = 0.003***

the knowledge of how to perform supportive supervision (P-value= 0.008), availability of resources to supervise immunization providers (P-value= 0.024), a lack of clear format for providing supportive supervision (P-value= 0.022), and a lack of recognition among providers on the importance of supportive supervision (P-value= 0.002).

Table 6 shows improvements in both the intervention and control districts for district level service delivery outcome indicators, but a greater improvement was observed in the intervention group. Results of univariate analysis (paired-sample t-test) indicate that in contrast to control districts, intervention districts significantly increased coverage rates for DPT-3 by 11.7% (P = 0.000), decreased contraindication rates by 1.93% (p = 0.057), decreased refusal rates by 1.47% (p= 0.044), and increased number of vaccinated children per 100 dose by five for DPT (p=0.016), by six for OPV (p=0.029), and by seven for HEP B vaccines (p=0.022).

When comparing the treatment groups in terms of the changes in district level outcome indicators from baseline to follow up (i.e. difference between groups for the "change magnitude") using ANOVA, it was found that the "change magnitude" was significantly higher in intervention group for the decrease in DPT vaccine wastage (p=0.021), decrease in OPV vaccine wastage (borderline significance, p=0.085), and for the increase in DPT-3 coverage (borderline significance, p=0.075) (Table 7).

The results of the FGDs of CPH and health care facility staff in intervention districts point to a number of improvements from baseline to follow up. These included: an improved management/supervision approach from punitive to supportive; improved knowledge of providers about contraindications to immunization; better clarification of the roles and responsibilities of staff at district CPH and facility level; an increased sense of job responsibility

Table 5 - Results of regression analyses assessing the impact of the intervention on individual level outcome indicators for knowledge and use of supportive supervision among immunization managers.

	Mean values from Likert scale			Regression results			
Outcome indicator, n = 26 observations	Treatment group	Pre-test	Post-test	Model*	F statistic	P-value	Partial Eta Squared
1. Perceived knowledge to carry out supportive supervision	Intervention Control	3.55 4.00	4.64 3.86	GLM repeated measures	5.235	**0.034**	0.216
2. Knowledge on how to do supportive supervision as a barrier	Intervention Control	3.55 3.86	1.73 3.86	GLM repeated measures	8.868	**0.008**	0.318
3. Availability of resources to supervise immunization providers as a barrier	Intervention Control	4.00 3.93	2.73 3.86	GLM repeated measures	5.970	**0.024**	0.239
4. Lack of clear format for providing supportive supervision as a barrier	Intervention Control	4.09 3.71	2.22 3.21	GLM repeated measures	6.173	**0.022**	0.245
5. Lack of recognition of importance of supportive supervision by providers as a barrier	Intervention Control	3.64 2.93	1.91 2.79	GLM repeated measures	13.573	**0.002**	0.417

*Regression models included: treatment group, age, years of experience in the current job, geographic area, and the interaction term "treatment group*geographic area".

Table 6 - Service delivery outcome indicators by treatment group and pre- and post-test.

	Mean %			Paired Samples
Service delivery outcome indicator 15 intervention and 15 control districts	Treatment group	Pre-test	Post-test	T test
1. DPT-3 coverage	Intervention	77.4%	89.1%	***P=0.000***
	Control	81.3%	84.8%	*P=0.371*
	ANOVA	*P=0.294*	*P=0.285*	
2. Polio-3 coverage	Intervention	64.1%	90.6%	***P=0.000***
	Control	65.2%	82.2%	***P=0.013***
	ANOVA	*P=0.499*	*P=0.173*	
3. Hep B-3 coverage	Intervention	62.9%	81.5%	***P=0.002***
	Control	58.8%	68.1%	***P=0.001***
	ANOVA	*P=0.139*	*P=0.172*	
4. Contraindications rate (mean for monthly contraindication rates to account for seasonal variation in contraindications)	Intervention	7.1%	5.2%	***P=0.057***
	Control	5.1%	4.7%	*P=0.432*
	ANOVA	*P=0.160*	*P=0.631*	
5. Refusal rate (mean for monthly refusal rates to account for seasonal variation in contraindications)	Intervention	5.9%	4.4%	***P=0.044***
	Control	6.5%	5.0%	*P=0.340*
	ANOVA	*P=0.782*	*P=0.606*	
6. Vaccine wastage DPT (calculated as number of vaccinated children per 100 dose)	Intervention	68	73	***P=0.016***
	Control	68	66	*P=0.387*
	ANOVA	*P=0.936*	*P=0.179*	
7. Vaccine wastage OPV (calculated as number of vaccinated children per 100 doses)	Intervention	65	71	***P=0.029***
	Control	62	62	*P=0.955*
	ANOVA	*P=0.554*	*P=0.036*	
8. Vaccine wastage HEPB (calculated as number of vaccinated children per 100 doses)	Intervention	73	80	***P=0.022***
	Control	66	68	*P=0.419*
	ANOVA	*P=0.353*	*P=0.125*	

regarding roles in immunization program; and an increased ability of CPH staff to carry out supportive supervision.

Despite aforementioned improvements, the FGDs highlighted several potential barriers that remained over the course of intervention and hinder the implementation of

Table 7 - Difference between treatment groups in the magnitude of change from baseline to follow up in the service outcomes (ANOVA).

Service delivery outcome indicator	Mean %	
15 intervention and 15 control districts	Treatment group	Magnitude of change
9. DPT-3 coverage	Intervention	11.7%
	Control	3.6%
	ANOVA	***P=0.075***
10. Polio-3 coverage	Intervention	26.5%
	Control	17.1%
	ANOVA	*P=0.159*
11. HepB-3 coverage	Intervention	12.5%
	Control	15.3%
	ANOVA	*P=0.586*
12. Contraindications rate (mean for monthly contraindication rates to account for seasonal variation in contraindications)	Intervention	-1.9%
	Control	-0.5%
	ANOVA	*P=0.192*
13. Refusal rate (mean for monthly refusal rates to account for seasonal variation in contraindications)	Intervention	-1.5%
	Control	-1.5%
	ANOVA	*P=1.000*
14. Vaccine wastage DPT (calculated as number of vaccinated children per 100 dose)	Intervention	4.9
	Control	-1.9
	ANOVA	***P=0.021***
15. Vaccine wastage OPV (calculated as number of vaccinated children per 100 doses)	Intervention	0.6
	Control	-0.1
	ANOVA	***P=0.085***
16. Vaccine wastage HEP B (calculated as number of vaccinated children per 100 doses)	Intervention	6.8
	Control	1.9
	ANOVA	*P=0.178*

Communication problems

"We have huge problem regarding communication as we have several immunization points that are located in remote areas. We don't have even transportation means to get there and contact with them is practically impossible as those territories are out of coverage area of cell networks" (Immunization manager)

Lack of regulations

"Supportive supervision must be included in the regulation and should be described well" (Facility manager)

Lack of penalties

"Supportive approach is more acceptable, however it has limits, and there must be some penalties if supportive supervision does not work" (Facility manager)

Low technical capacity

"Technical skills and capacity of providers for immunization work needs further improvement, more trainings are needed" (CPH director)

Figure 1 - Quotations from focus group discussions regarding health system barriers.

the intervention and the use of certain tools to their fullest extent (Figure 1). The barriers mentioned included: communication problems with remote health facilities; lack of official regulations on supportive supervision; lack of CPH authority to impose penalties on low-performing health facilities; low technical capacity of local health providers; and inability to give financial incentives to well performing facilities and providers.

Discussion

The results of the study suggest that the intervention package, which included supportive supervision guidelines, district-level trainings, continuous supervision and support during a 12 month period, monitoring and evaluation of provider performance and funding for district CPH to carry out the supportive supervision missions (travel and communication costs), were implemented as planned. As for the number of expected improvements among immunization managers, the intervention independently contributed to improved knowledge of supportive supervision, and helped remove self-perceived barriers to supportive supervision such as availability of resources to supervisors, lack of clear format for providing supportive supervision, and lack of recognition among providers on the importance of supportive supervision.

Similarly, the results of the analysis show that improvements were recorded in both the intervention and control districts for district level service delivery outcome indicators; however, a greater improvement was observed in the intervention group. This latter observation can be attributed to the intervention package that independently contributed to improved service outcomes, namely, decreasing vaccine wastage and increasing immunization coverage. The obvious trend in improvement of service outcomes in both intervention and control districts can be attributed to other factors such as an overall improvement in health care financing and targeted service provision to the poor that took place in the country over the course of intervention [16]. Positive country-level economic growth may have also contributed to the improved population access to health care, [17] resulting in the improved immunization coverage rates. Prior to implementation of our study in 2004, a considerable proportion of the Georgian population faced financial access barriers to health care [18]. Furthermore, interventions aimed at increasing access to services may improve performance of the immunization program [19]. The health care financing initiatives of the Government of Georgia certainly helped improve access to services for the population and most importantly for the poor [16]. Therefore, it is possible that improved access to health care may have contributed to improved immunization coverage rates in Georgia.

An equal but modest decrease in the rate of refusals to vaccination (as declared by parents) in both intervention and control districts was found. A Georgian study conducted in 2002 showed that the community members in Georgia had little knowledge of Vaccine Preventable Diseases (VPD); in particular, there was inadequate knowledge of how VPDs are transmitted, of the complications of VPDs as well as inadequate knowledge regarding the safety of immunization and the quality of vaccines [20]. It has been shown that strategies to increase demand through improving knowledge among clients regarding need for vaccination are useful [19]. It is possible that some improvement in community members' knowledge of VPDs in both intervention and control districts occurred, however this was not assessed in our study.

Limitations

The results should be cautiously interpreted given the limitations of this study. First, most individual level data are subjective and social desirability bias may have confounded the results one year after the intervention. Second, there is the possibility that a modest role of intervention in improving service outcomes could be due to a type 2 error, resulting from inadequate number of districts (budgetary limitations would not allow to expand intervention to more districts) to ensure enough power of the study to ascertain greater effect of the intervention in the observed changes in the service outcomes. Finally, the short duration of the intervention may have restricted the intervention's potential to bring the expected outcomes.

Conclusions

Provider-based interventions such as supportive supervision can have independent positive effects on immunization program indicators. Thus, it is recommended to implement supportive supervision within the framework of national immunization program in Georgia and other countries in transition with similar institutional arrangements for health services organization.

List of abbreviations used

ANOVA – Analysis of variance; CPH – Centre of public health; FGDs – Focus group discussions; GLM – Generalized linear model; MIS – Management information system; NIP – National Immunization Program; VPD – Vaccine preventable disease

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

The authors contributed to the conception, design, and interpretation of the study. MD conceived, drafted and finalized the manuscript. GG and AZ contributed to the conception of the manuscript and drafting the manuscript.

MD, GG and AZ contributed to the implementation of study in Georgia. GM, LE and JCK conducted review and provided comments on the manuscript.

Additional material

Additional file 1

Abstract in Russian.
Available from:
http://www.biomedcentral.com/content/supplementary/1472-698X-9-S1-S11-S1.doc

Acknowledgements

This work was carried out with the aid of a grant from the International Development Research Centre (IDRC), Ottawa, Canada, as part of the Canadian International Immunization Initiative Phase 2 (CIII2). This initiative is a project of the Global Health Research Initiative (GHRI). This research grant provided the funding for the implementation of the study of supportive supervision in Georgia. We thank and acknowledge contribution of the staff of Curatio International Foundation involved in acquisition of data: Natia Rukhadze, Natalia Zakareishvili, and Tea Kutateladze.

This article is published as part of *BMC International Health and Human Rights* Volume 9 Supplement 1, 2009: The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants. The full contents of the supplement are available online at http://www.biomedcentral.com/1472-698X/9?issue=S1.

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Monitoring the performance of the Expanded Program on Immunization: the case of Burkina Faso

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from The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants

Published: 14 October 2009

BMC International Health and Human Rights 2009, **9**(Suppl 1):S12 doi:10.1186/1472-698X-9-S1-S12

This article is available from: http://www.biomedcentral.com/1472-698X/9/S1/S12

Abstract

Background: The greatest challenge facing expanded programs on immunization in general, and in Burkina Faso in particular, lies in their capacity to achieve and sustain levels of immunization coverage that will ensure effective protection of children. This article aims to demonstrate that full immunization coverage of children, which is the primary indicator for monitoring national immunization programs, is sufficient neither to evaluate their performance adequately, nor to help identify the broad strategies that must be implemented to improve their performance. Other dimensions of performance, notably adherence to the vaccination schedule and the efficacy of the approaches used to reach all the children (targeting) must also be considered.

Methods: The study was carried out using data from surveys carried out in Burkina Faso: the 1993, 1998 and 2003 Demographic and Health Surveys and the 2003 national Survey of Immunization Coverage. Essentially, we described levels of immunization coverage and their trends according to the indicators considered. Performance differences are illustrated by amplitudes and maximum/minimum ratios.

Results: The health regions' performances vary according to whether they are evaluated on the basis of full immunization coverage or vaccination status of children who have not completed their vaccinations. The health regions encompass a variety of realities, and efforts of substantially different intensity would be required to reach all the target populations.

Conclusions: Decision-making can be improved by integrating a tripartite view of performance that includes full immunization coverage, adherence to the vaccination schedule (timely coverage),

and the status of children who are not fully vaccinated. With such an approach, interventions can be better targeted. It provides information on the quality and timeliness of vaccination and identifies the efforts required to meet the objectives of full immunization coverage.

Abstract in French: See the full article online for a translation of this abstract in French.

Abstract in French

See Additional file 1 for a translation of the abstract to this article in French.

Background

Substantial efforts have been made by sub-Saharan African countries to reinforce their immunization programs. One of the major challenges facing immunization services is to achieve and sustain the high levels of performance necessary for complete and appropriate coverage of target populations [1-3]. Usually, the monitoring of immunization services performance is done by compiling and analyzing indicators of completeness. These show the extent to which immunization programs were able to vaccinate targeted children against the entire group of antigens targeted by the Expanded Program on Immunization (EPI): BCG, diphtheria, tetanus, pertussis, poliomyelitis, measles, and yellow fever. The measures generally used indicate the proportion of children who are fully vaccinated (full immunization coverage (FIC)) or vaccinated for specific antigens (particularly DTCP3) [4,5]. This process is restrictive, however, in that it only takes into account the number of vaccines received, but not the age of the child at the time of vaccination and the adherence to the vaccination schedule. The use of FIC as an indicator of the effectiveness of immunization programs leads to categorizing targeted children into two groups: those fully vaccinated and those not fully vaccinated. This dichotomy has the advantage of simplicity, but it oversimplifies the reality, which is that both categories include a broad spectrum of different situations in terms of vaccination efficacy and adequacy. It results, for example, in children who are fully vaccinated being considered "successes" whether or not the vaccination schedule was adequately respected. This group thus includes children vaccinated too late or too early, whose chances of being really immunized are thereby limited. When all is said and done, the homogeneity of the "fully vaccinated" group of children is only ostensible, and health regions that are considered to be high-performing in terms of coverage may actually be performing at a mediocre level if we take into account the children's age at vaccination and the degree to which the vaccination schedules of the target populations were respected. This is confirmed by several studies carried out in sub-Saharan Africa. In Malawi, a recent study shows that while 93% of children had received their third dose of DTC by the age of 23 months, only 2% had received it at the recommended age of 14 weeks, and 49% at six months [6]. The same trend is seen with both BCG (95% coverage at 15 months, only 22% at one week and 53% at six weeks) and measles. In the Central African Republic, Kahn et al. reported a pattern of late vaccination for measles [7]. They calculated that vaccinated children who had an opportunity for earlier vaccination were, on average, exposed to 70 "days-at-risk of measles" (age at vaccination in days minus 270, which is the recommended age for vaccination). In rural areas, the average delay was more than three months (98 days). Other studies mention vaccinations that are too early. A survey in Mozambique reports that among all children who had received all required vaccines, one out of 10 had received the measles vaccine before 8.5 months of age [8]. In the previously mentioned study in Malawi, 17% were vaccinated against measles before nine months of age.

In addition, this dichotomy does not take into account possible disparities in vaccination status among the group of children considered not fully vaccinated. It obscures the fact that some children in this group have received no vaccine at all, while others are missing only one or two, to have full coverage. Thus, regions with good FIC performance can show poor performance in their capacity to improve this indicator, since the proportions are high of children with no vaccine and those missing one or two. Therefore, analyzing the outcomes of immunization activities and evaluating program performance require using an array of indicators that take into consideration both quantitative (ability to reach targeted children) and qualitative (respecting the vaccination schedule for children reached in the targeted population) dimensions of vaccination.

In this article, we propose an approach to performance analysis based on the efficacy of the targeting of children to be vaccinated. Appropriate targeting is defined by the EPI's capacity, on the one hand, to reach the targeted children, and on the other, to vaccinate those children in accordance with the vaccination schedule. We intend to show that such an approach, simple in its application and requiring no particular skills of analysis, makes it possible to go beyond the general indications provided by the rough indicators of coverage and obtain a truer picture of the real immunization activities in regions or health

districts. It offers the potential to uncover territorial entities whose actual poor performance is masked by levels of gross immunization coverage that appear satisfactory, and, in so doing, contributes more effectively to the development of strategic orientations. However, in this paper, which is essentially focused on the development and utilization of more precise performance indicators for vaccination programs, we will not deal with the reasons underlying why vaccination schedules are not respected and coverage is adequate or inadequate. The reader interested in these issues may consult the scant literature on this topic, particularly the studies of Jahn in Malawi [6].

Methods

Sources of data

The data we used were taken from three Demographic and Health Surveys (DHS) —1993, 1998, 2003 — and the Immunization Coverage Survey (ICS) carried out in 2003 at the level of health districts in Burkina Faso. The DHS is a national survey carried out using a standardized methodology [9–11]. The surveys of 1993 and 1998 used a division of the country into five economic regions while that of 2003 was based on the country being divided into 13 administrative regions that correspond also to the health regions. The samples of the three surveys are briefly described in Table 1.

The ICS was based on the cluster method developed by WHO [12,13]. Each cluster consists of at least seven children between the ages of 12 and 23 months and seven mothers of babies from 0 to 11 months of age. The sampling frame was the population of each health district: 30 clusters were selected per health district, and thus, at the national level, there were 1560 clusters. Sampling took into account the demographic importance of the villages and the sectors of communes, thereby ensuring good proportional representation. The identification of clusters was done using COSAS software and the National Health Information System file of the Direction des études et de la Planification. In each cluster selected, the seven children are identified in households by moving from one relation to another, extending outward from a central point.

Vaccination schedule, evaluation criteria

The vaccination schedule used in Burkina Faso during the period covered by the three DHSs and the ICS is presented in Table 2. The immunization coverage rates that are considered in the DHSs and the ICS are estimated from the children's health booklets presented by the mothers or, for the BCG vaccine, from the surveyor's direct observation of a scar. A child's coverage is considered to be complete if he has received one dose of BCG, three of DTP, one of measles vaccine, and one of yellow fever vaccine. The child is considered to have been correctly vaccinated (timely vaccination) if the minimum interval between two doses of DTP is 28 days and if the child was vaccinated for measles and yellow fever no sooner than 255 days after birth.

Table 1 - Demographic and Health Surveys (DHS) in Burkina Faso: Sample and territorial representation.

Year	Territorial representation	Sample (*n*)
1993	5 economic regions	1104
1998	5 economic regions	1041
2003	13 health regions	1840

Table 2 - Burkina Faso: Vaccination schedule.

Contacts	Age at vaccination	Recommended antigens
1	Birth	BCG, polio 0
2	2 months	DTCP1, polio 1
3	3 months	DTCP2, polio 2
4	4 months	DTCP3, polio 3
5	9 months	Measles, yellow-fever vaccines

Analysis

Full immunization coverage is the primary indicator used to illustrate EPI performance (at the national and regional levels) and its evolution over the three periods (1993, 1998, and 2003). The second indicator is timely coverage. We used two scenarios for timely coverage in order to better assess the requirements entailed by adherence to the vaccination schedule. For a child to be considered correctly vaccinated, fixed time intervals were set for administration of the DTCP and the measles vaccines, as well as the yellow fever vaccine. Thus, in the first scenario we consider the vaccination to be timely if the interval between the first and third doses of DTCP is less than 60 days, and if the vaccine for measles and yellow fever is administered no sooner than 255 days and no later than 360 days after birth. The second scenario is less conservative: we consider vaccination to be timely if the interval between the first and third doses of DTCP is less than or equal to 90 days, with the same requirements as above for the measles and yellow fever vaccines. Comparative analysis of the evolution of the FIC and of timely coverage is carried out at the regional level for 1993 and 1998. Finally, to compare the performances of the health regions, we use a third group of three indicators that describe the vaccination status of children who have not completed their vaccinations: percentages of children who have received no vaccine, have missed only one, or have missed two vaccinations on the schedule.

Results

The estimate of FIC for 2003 provided by the ICS is 52.2%, with quite substantial regional variations. The

Table 3 - Vaccination coverage in Burkina Faso 1993–2003.

Indicator	Source of information			
	ICS2003	DHS2003	DHS1998	DHS1993
National immunization coverage				
FIC (full immunization coverage)	52.1	44.0	28.8	34.0
BCG	90.3	81.0	72.6	86.3
DTCP3	77.0	57.0	41.3	40.6
Measles	71.6	56.0	49.0	61.1
Regional disparities in immunization coverage (FIC)				
Region with lowest FIC	31.0	33.1	7.1	–
Region with highest FIC	72.0	61.6	37.7	–
Ratio Max /Min	2.3	1.9	5.3	–
Rate of loss to follow-up				
DTCP1/DTCP3	–	18.3	31.6	48.3
BCG/DTCP3	–	21.2	39.1	52.3
Appropriateness of targeting				
DTCP1: children vaccinated before their 3rd month of life	–	47.9	37.6	28.2
DTCP3: children vaccinated before their 5th month of life	–	27.5	22.5	18.8
Measles: children vaccinated between the 9th and 12th months of life	–	73.5	67.8	67.4
Children correctly vaccinated among those completely vaccinated – Scenario 1	–	36.2	27.8	26.6
Children correctly vaccinated among those completely vaccinated – Scenario 2	–	55.5	46.8	45.6
Children completely and correctly vaccinated – Scenario 1	–	14.1	7.3	7.9
Children completely and correctly vaccinated – Scenario 2	–	21.5	12.2	13.6

*Children who received the first vaccination cited, but not the second.

estimates provided by the DHSs are more conservative and reveal a positive progression of immunization coverage in the period 1998-2003 (Table 3). All the rough indicators of coverage converge and indicate an increase in coverage for the various antigens, a decrease in children lost to follow-up of BCG/DTCP1 and DTCP1/DTCP2, and a relative reduction in regional disparities. However, the picture presented by the rough indicators of coverage is much less impressive once the quality of the targeting is taken into account. Even the least conservative scenario reveals a disturbing situation. With barely one child out of five having been correctly and appropriately vaccinated in 2003 and, among those fully vaccinated, scarcely one out of two having been vaccinated in accordance with the norms of the vaccination schedule, population coverage and national EPI performance remain limited.

The current discrepancy between complete coverage and timely coverage is largely due to the late vaccination of children, as shown in Figures 1a to 1e. Thus, in 2003, fewer than half (42.5%) of the children vaccinated with BCG received it in their first month of life (Figure 1a), and 18% had received it after the age of three months (Figure 1b). More than one-third (36%) of vaccinated children had received their third dose of DTCP after the age of six months, and 20% after the age of nine months (Figures 1e, 1f). Finally, only 7% of children vaccinated against measles were vaccinated at the age of nine months; 5% were vaccinated before nine months, 65% between months 10 and 12, and 17.4% at 13 months and over (Figures 1c, 1d). However, the six figures show — and it is here that we see the value of the indicators used — that the quality of targeting of children improved significantly between 1998 and 2003 for each of the three vaccinations (Table 4). In the case of BCG, for example, children are vaccinated earlier and earlier, and the vaccination schedule is better respected. The low rates of coverage in assisted deliveries in health facilities partly explain why half the children receive their BCG vaccine late, at the age of one month. The situation is also improving for measles and DTCP3.

Table 5 presents the performance, in terms of immunization coverage, of the country's five large territories in 1993 and 1998 (comparable data are unfortunately not available for 2003 because of the administrative reconfiguration of the regions). Whatever indicator is used, the performances of the regions vary considerably. The central region, which includes the urban region of the capital, presents levels of performance significantly higher than the others (Table 5). In every case, the proportion of children who are correctly vaccinated appears low, regardless of the region, although there has been a tendency toward improvement over the years. The performances of the regions are better if we consider the longer intervals between the first and third doses of DTCP, which reflect the tendency to vaccinate somewhat later those children who have already received their first dose of DTCP. The administrative reports we consulted suggest that this will be repeated in 2003 [12], but always with the

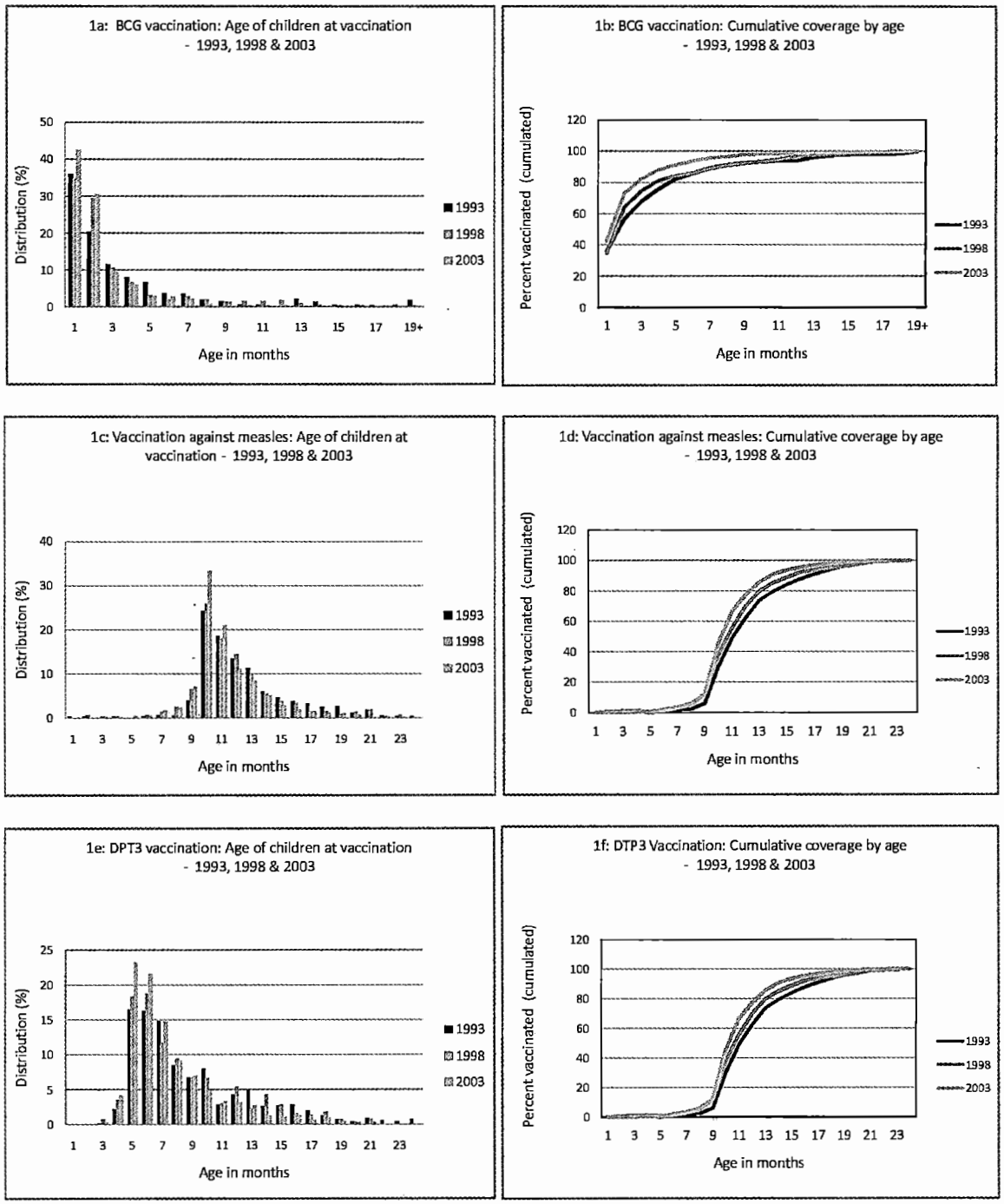

Figure 1 - Age of children at vaccination and cumulative coverage by age: BCG, Measles, DTCP3 – 1993, 1998 and 2003.

considerable disparity between the central region and the rest of the country.

It is interesting to note that the regions where FIC is greatest are also those where the vaccination schedule is generally better respected, and inversely (Figure 2), in both urban and rural areas. One exception to this is in the East region. As with FIC, the proportion of children correctly vaccinated in the rural area is considerably lower than in the urban area. In both areas, there was significant

Table 4 - Age (months) at vaccination of children for BCG, measles and DTCP.

Year	1993	1998	2003
BCG			
Total vaccination coverage (%)	70.0	49.4	59.5
Mean age at vaccination	2.6	2.3	1.5
Median age at vaccination	1.0	1.0	1.0
Standard deviation	3.9	3.4	2.4
Measles			
Vaccination coverage	50.9	35.3	45.4
Mean age at vaccination	11.4	10.8	10.3
Median age at vaccination	11.0	10.0	10.0
Standard deviation	3.2	3.1	2.5
DTCP1			
Vaccination coverage	66.8	45.7	59.8
Mean age at vaccination	4.8	4.5	3.5
Median age at vaccination	3.0	3.0	3.0
Standard deviation	3.8	3.8	2.9
DTCP2			
Vaccination coverage	55.8	39.1	55.3
Mean age at vaccination	7.1	6.2	5.2
Median age at vaccination	6.0	5.0	4.0
Standard deviation	4.0	3.8	3.1
DTCP3			
Vaccination coverage	34.4	31.7	48.9
Mean age at vaccination	8.0	7.5	6.6
Median age at vaccination	7.0	6.0	6.0
Standard deviation	4.2	3.8	3.2

Source: DHS 1993, 1998, 2003.

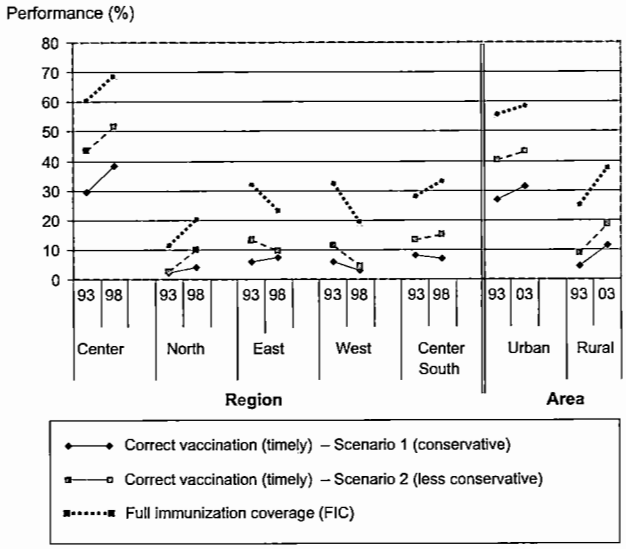

Figure 2 - Evolution of FIC and appropriate coverage by regional groupings.

improvement between 1993 and 2003. The fact that both FIC and timely coverage are moving in the same direction is an encouraging sign (Figure 2).

Table 6 presents regional performance with respect to the vaccination status of children who had not yet completed their vaccinations in 2003 (source: ICS). A first group consists of three health regions where a high proportion (more than 40%) of children with incomplete vaccination actually had no vaccinations at all. These are the regions of Hauts-Bassins, Plateau-Central, and Sahel. In other words, in these regions there are still enormous needs among the population of children whose vaccinations are incomplete. A second group is made up of regions in which a high proportion of children with incomplete vaccinations have missed only one. While coverage of these children is incomplete, most of them have completed two of the three required vaccination sequences and would need only one complementary vaccine to be completely covered. These regions are the North, Center-West, Center, and Boucle du Mouhoun. The six other regions are in an intermediate position. The children who are not completely vaccinated are distributed relatively evenly among those having received no vaccines, those missing one, and those missing two. These three groupings convey not only different levels of performance among the health regions, but also situations

Table 5 - Vaccination coverage by large regional groupings in 1993 and 1998.

	1993			1998		
		Timely coverage			Timely coverage	
Region	Gross coverage (FIC)	Scenario 1	Scenario 2	Gross coverage (FIC)	Scenario 1	Scenario 2
Center	60.4	29.4	43.5	69.1	38.2	51.8
North	11.4	2.2	2.7	20.3	4.1	10.1
East	32.1	5.7	13.4	23.1	7.2	9.5
West	32.3	6.0	11.4	19.2	2.9	4.5
Center-South	27.9	8.1	13.4	33.1	7.0	15.2

Scenario 1: Children completely and correctly vaccinated (measles at 9-12 months and DTCP 1-3 intervals of ≤2 months).
Scenario 2: Children completely and correctly vaccinated (measles at 9-12 months and DTCP 1-3 intervals of ≤3 months).
Source: DHS 1993, 1998.

Table 6 - Vaccination status of children with incomplete coverage by health region.

	Children not completely covered		Distribution of children whose vaccinations are incomplete (%)		
Region	N	%	No vaccination	Missing one vaccination	Missing two vaccinations
Hauts-Bassins	159	62	47	25	28
Plateau Central	56	55	46	31	23
Sahel	108	77	42	35	23
East	73	56	37	30	33
Cascades	32	48	35	24	41
Center-East	88	56	30	27	43
Center-North	77	41	29	30	41
Center-South	44	48	26	34	40
South-West	41	47	25	24	51
North	148	72	23	44	33
Center-West	75	64	22	30	48
Center	50	37	13	60	27
Boucle du Mouhoun	80	50	11	48	41
TOTAL	1031	100	31	34	35

Source: DHS 2003.

that will require efforts of varying levels of intensity to achieve the goals of complete coverage and to address the unmet needs of target populations effectively.

The regions' performances are different depending on whether we are looking at the level of FIC or the vaccination status of children who have not completed their vaccinations. Some regions perform well in terms of the former, but not the latter (notably Center-East and Center-South). Conversely, some regions have poor FIC performance, but a major part of their incomplete vaccinations consists of children who have missed only one vaccine. Thus, for example, the Boucle du Mouhoun region ranks nine out of 13 in terms of FIC, but with respect to children with incomplete vaccination, it has the lowest proportion of children who have never had a vaccine.

Discussion

Numerous efforts have been made over recent decades to broaden the availability of vaccination services in Burkina Faso, such as a policy to achieve autonomy in vaccination by purchasing vaccines through the national budget, and extension of service coverage [12]. This article proposes a simple and practical approach to help decision makers assess EPI performance and progress, in order to identify high-priority and more specific needs for intervention.

The most commonly used indicator, FIC, allows for the evaluation, up to a certain point, of national EPI performance and its progress and of disparities among health regions. However, as we have seen, this indicator does not take into account the heterogeneity of situations encountered related to respecting the vaccination schedule, and particularly to delays in the administration of one or several vaccines. Little is known about the population impacts of these incorrect vaccinations on the outcomes of vaccination programs, which will need to be better documented. However, they may be greater than expected. In Germany, Siedler et al., found that "50% of measles cases in 1-year old children would be prevented if presently observed vaccine coverage rates in the third year of life could be achieved 12 months earlier" [14]. A delay in the administration of one vaccine could not only increase the child's vulnerability to the antigen concerned, but also weaken adherence to subsequent vaccination [15] and thereby increase the risk that the child will never complete the vaccination course [16]. Finally, a high level of incorrect vaccinations could significantly affect these programs' ability to lower vaccine-preventable mortality. In Bangladesh, Brieman et al. showed that children vaccinated with BCG before the age of six months are at considerably lower risk of dying in the first five years of life than are children vaccinated later (hazard rate: 0.47-0.73) [17].

Thus, timeliness of vaccine coverage complements the information provided by FIC. It offers a more precise rendering of EPI efficacy, provides more plausible measures of the actual immunization of target populations and thereby offers better information on the quality of processes. Where targeting is perfect, these two indicators coincide. However, this is far from the case in Burkina Faso, where it seems the priority issues are related as much to improving vaccination processes as to extending coverage. It is nevertheless interesting to note that there is a fair amount of concordance between the level of gross coverage and the quality of processes as indicated by the measurement of timely coverage (Table 5). With only one exception, this concordance is also observed in the progress of performances among the health regions at the disaggregate level.

Examining the vaccination status of children who are not fully vaccinated allows us to refine the EPI performance

Table 7 - Ratings of health regions according to three performance criteria.

	Rating		
Region	Level of FIC	Proportion of children with no vaccine	Level of timely coverage
Center	1	2	2
Center-North	2	7	3
Center-South	3	6	1
Center-East	4	8	4
South-West	5	5	12
East	6	10	6
Cascades	7	9	8
Plateau Central	8	12	11
Boucle du Mouhoun	9	1	10
Hauts-Bassins	10	13	7
Center-West	11	3	9
North	12	4	5
Sahel	13	11	13

analysis and to determine more precisely both the scope of the needs to be addressed and the interventions required to achieve complete and timely coverage. At the national level, 31% of children who are not fully vaccinated have received no vaccine at all, which means that nearly one-third of non-vaccinated children have had no contact with immunization services. At the regional level, the high proportion of children having had no vaccine among those not fully vaccinated represents a problem of inadequate immunization strategies. The effort required to respond to the needs of these children is substantial. Why are so many children never reached? To what extent are these children concentrated in populations that are poor, far from points of service, or vulnerable, and also, to what extent do these children lost to follow-up reflect existing health inequities? More detailed analysis of local strategies would help in understanding the reasons and the systemic deficiencies at play. Conversely, in the regions where the proportion of children who have received no vaccine is low, the problem has less to do with the appropriateness of the overall strategy and the quality of the processes for reaching targeted children, than with the capacity of the services in place to guarantee the completeness of the vaccinations carried out.

Our results show that, in the regions, the level of complete coverage is poorly correlated with the proportion of children not vaccinated at all, and consequently, it is not very useful for estimating the scope of work to be carried out (Table 7). Comparing the ratings of the regions on the basis of the three performance criteria we used reveals not only their complementarity, but also the limitations of any analysis of coverage that is focused exclusively on complete coverage. Some regions that rate well on the FIC criterion are in a lower position when it comes to the proportion of children who received no vaccine at all. Conversely, the ratings of regions such as the North, Center-West, and Boucle du Mouhoun improve when we move from FIC to children with no vaccine. Finally, some regions such as Hauts-Bassins, Sahel, and South-West have relatively stable ratings.

These results indicate that, in analyzing EPI performance, taking into consideration both FIC and targeting will provide better vantage points from which decisions can be taken to improve the situation. In certain regions such as Sahel, Hauts-Bassins, and Plateau-Central, not only is FIC low, but the outlook for improvement is poor because of the inadequate strategies in place. In the Center-North, Center-East, and East regions, the current inadequacy of the immunization strategies will eventually make it difficult to improve complete coverage which is, for the moment, relatively good. On the other hand, in the regions of Boucle du Mouhoun, North, and Center-West, the results suggest that the current low level of FIC could be improved quite significantly by placing greater emphasis on improving the efficacy of current strategies for completing vaccinations.

Conclusions

The goal of the EPI is to achieve a significant reduction in vaccine-preventable diseases. From this perspective, the national objective is to ensure complete and timely immunization coverage for 80% of targeted children [12]. In recent decades, substantial progress has been made in immunization coverage. To sustain this trend, more precise information is needed on EPI performance. The results of the present study indicate that decision-making can be improved by integrating a tripartite view of performance that includes FIC, adherence to the vaccination schedule (timely coverage), and the status of children who are not completely vaccinated. Using such an approach, interventions can be better targeted and help to reduce inequities in health care and access to vaccination. In effect, combined analysis of these three dimensions at the district, regional, and national levels enables us to identify more clearly the extent to which children have received all the doses of vaccines, and the extent to which these doses respected the vaccination schedule, as well as the exact status of those who did not receive all the doses. At this time, there are studies [18–22] that have documented the various determinants of the elements of this performance, notably with respect to adherence to the vaccination schedule and full immunization coverage. More detailed studies should make it possible to better understand the reasons underlying the performance deficiencies encountered.

List of abbreviations used

DHS – Demographic and Health Survey; EPI – Expanded Program on Immunization; FCI – Full immunization coverage; ICS – Immunization Coverage Survey.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

AB coordinated the study. As principal investigators, AB and SH were responsible for all scientific aspects of the work. All authors were involved in the preparation of the research project, the analyses, and the drafting of the manuscript. MK and ET were responsible for interactions with decision makers and stakeholders. MF supervised analysis of the databases and the formulation of results. PF provided scientific support during the various phases of the study. All authors provided feedback and made revisions to the manuscript.

Additional material

Additional file 1

Abstract in French.
Available from:
http://www.biomedcentral.com/content/supplementary/1472-698X-9-S1-S12-S1.doc

Acknowledgements

This work was carried out with the aid of a grant from the International Development Research Centre (IDRC), Ottawa, Canada, as part of the Canadian International Immunization Initiative Phase 2 (CIII2). This initiative is a project of the Global Health Research Initiative (GHRI). The authors wish to thank IDRC for its support for studies carried out in the context of the research program on "Inequalities in access to immunization in West Africa". We extend our thanks most particularly to the Governance, Equity and Health group, as well as to Donna Riley for translation of the manuscript.

This article is published as part of *BMC International Health and Human Rights* Volume 9 Supplement 1, 2009: The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants. The full contents of the supplement are available online at http://www.biomedcentral.com/1472-698X/9?issue=S1.

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BMC International Health and Human Rights

Research

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Evaluation of immunization coverage within the Expanded Program on Immunization in Kita Circle, Mali: a cross-sectional survey

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from The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants

Published: 14 October 2009

BMC International Health and Human Rights 2009, **9**(Suppl 1):S13 doi:10.1186/1472-698X-9-S1-S13

This article is available from: http://www.biomedcentral.com/1472-698X/9/S1/S13

Abstract

Background: In 1986, the Government of Mali launched its Expanded Program on Immunization (EPI) with the goal of vaccinating, within five years, 80% of all children under the age of five against six target diseases: diphtheria, tetanus, pertussis, poliomyelitis, tuberculosis, and measles. The Demographic and Health Survey carried out in 2001 revealed that, in Kita Circle, in the Kayes region, only 13% of children aged 12 to 23 months had received all the EPI vaccinations. A priority program was implemented in 2003 by the Regional Health Department in Kayes to improve EPI immunization coverage in this area.

Methods: A cross-sectional survey using Henderson's method (following the method used by the Demographic and Health Surveys) was carried out in July 2006 to determine the level of vaccination coverage among children aged 12 to 23 months in Kita Circle, after implementation of the priority program. Both vaccination cards and mothers' declarations (in cases where the mother cannot make the declaration, it is made by the person responsible for the child) were used to determine coverage.

Results: According to the vaccination cards, 59.9% [CI 95% (54.7–64.8)] of the children were fully vaccinated, while according to the mothers' declarations the rate was 74.1% [CI 95% (69.3–78.4)]. The drop-out rate between DTCP1 and DTCP3 was 5.5%, according to the vaccination cards. The

rate of immunization coverage was higher among children whose mothers had received the anti-tetanus vaccine [OR = 2.1, CI 95% (1.44–3.28)]. However, our study found no difference associated with parents' knowledge about EPI diseases, distance from the health centre, or socio-economic status. Lack of information was one reason given for children not being vaccinated against the six EPI diseases.

Conclusions: Three years after the implementation of the priority program (which included decentralization, the active search for missing children, and deployment of health personnel, material and financial resources), our evaluation of the vaccination coverage rates shows that there is improvement in the EPI immunization coverage rate in Kita Circle. The design of our study did not, however, enable us to determine the extent to which different aspects of the program contributed to this increase in coverage. Efforts should nevertheless be continued, in order to reach the goal of 80% immunization coverage.

Abstract in French: See the full article online for a translation of this abstract in French.

Abstract in French

See Additional file 1 for a translation of the abstract to this article in French.

Background

Vaccination is the most effective means of combating disease. Vaccines exist for a great many dangerous infectious diseases. The introduction of vaccines, particularly among children, has led to significant reductions in morbidity and mortality from these diseases, thereby lowering the infant mortality rate. However, in sub-Saharan Africa, despite the availability of these vaccines and efforts on the part of governments and their partners to make them accessible, the mortality rate for children under the age of five remains among the highest in the world [1]. In 1974, the World Health Organization (WHO) launched the Expanded Program on Immunization (EPI) to make vaccines available to all children worldwide [2]. In Mali the government launched its EPI in 1986 with the goal of vaccinating, within five years, 80% of all children under the age of five against six target diseases: diphtheria, tetanus, pertussis, poliomyelitis, tuberculosis, and measles. After many years, this goal is far from being reached [3,4], and in 2006, the infant mortality rate was 119 per 1 000 and child mortality, 217 per 1,000 — both rates still among the highest in the world [5]. Fifteen years after the EPI's inauguration, the 2001 Demographic and Health Survey (DHS-III) [6] revealed that, according to vaccination records or mothers' declarations, only 32% of children between the ages of 12 and 23 months had received all the EPI vaccinations. This poor performance was even more striking in the Kayes region in the northwest area of the country, including Kita Circle (a circle being an administrative district), where only 13.6% of children aged 12 to 23 months had been fully vaccinated.

The DTCP1 to DTCP3 drop-out rate in the Kayes region was among the highest in Mali (60%); in other regions of the country the rate ranged from 12% to 50% (DHS-II, DHS-III) [7]. The very great disparity between the routine data (which allows health personnel of the Kayes region to plan EPI activities based on "coverage rates" of around 70%) and DHS data (with rates of fully vaccinated children being under 15%, without taking into consideration whether they were correctly vaccinated), must have shaken the convictions of health personnel in the Kayes region, and especially those of the regional authorities. In fact, the administrative authorities based themselves largely on the results from the National Immunization Days (NID), which have a rate of coverage of more than 90% [7]. For these reasons, in 2003, the Regional Department of Health in Kayes developed a priority program to improve the EPI's rate of immunization coverage.

This priority program had seven main components:

1. The creation of community health centres (CSCom – Centres de santé communautaire) for each 5 000 habitants. Each CSCom was provided with the human and material resources required to carry out vaccination sessions within a radius of 15 km. Before the implementation of this program, vaccination units at times had to vaccinate children within a radius of 100 km.

2. The creation of a health committee within each village. Each committee was composed of two villagers (one male and one female) who were called "intermediaries". They received training on the EPI (targeted diseases and vaccinations schedule) and were provided with a register allowing them to record all pregnant women in the village, all births, all children between the ages of 0 and 5, and the vaccination calendars for these children. These intermediaries were in regular contact with vaccination teams, which allowed them to know the dates of vaccination sessions and thereby inform villagers in advance. Upon the arrival of vaccinators, the intermedi-

aries would accompany them in the village, and would thereby know, at the end of the vaccination session, which children were missing. When vaccinators left, they would enquire about the reasons why children had missed the vaccination session and plan for them to attend the following one. This was known as the active search for missing children.

3. The purchase of a motorcycle, its maintenance, and the purchase of fuel for the vaccination team.

4. The purchase of a 4X4 vehicle, its maintenance, and the purchase of fuel for the supervision team.

5. The purchase of equipment for, and maintenance of, the cold chain.

6. The purchase of vaccination cards.

7. The regular payment of per diems for the training and supervision sessions.

This priority program was mainly financed by the Global Alliance for Vaccines and Immunization (GAVI). Here, we report on the results of an evaluation of the vaccination coverage rate three years after the implementation of the priority program in the Kayes region. We did not, however, evaluate the priority program itself.

Methods

Location of the study

The study took place in Kita Circle, which was selected as representative of the Kayes region. Kita Circle is located in the southwest part of the Kayes region and has a land area of 35 250 km^2. It has an estimated population of 338 551 people distributed among 330 villages regrouped into 33 communes, of which 2 are urban and 31 rural. The circle is served by a railway line linking it to Bamako and Kayes, at distances of 186 and 307 km, respectively. At the time of the study, the circle had only regional roads and rural tracks; there were no asphalt roads. In addition to its connection to the telephone network, the circle had seven local radio stations as well as traditional methods of communication. The national television covered approximately 30% of the circle's territory.

As in the rest of the country, the EPI vaccines are administered according to the calendar set out by WHO [8]: Polio 0 and BCG in the first 15 days after birth; DTCP1, DTCP2, and DTCP3 at, respectively, 6, 10, and 14 weeks after birth; measles and yellow fever, at nine months of age. The viral hepatitis B and *haemophilus influenzae* type B vaccines, introduced more recently into Mali's EPI, are administered in combination and at the same time as DTCP1, DTCP2, and DTCP3.

Outline of the study

The survey was carried out in July 2006 in three health areas of the circle (Djidjan, Fladougou, and Kasaro) and was focused on children between the ages of 12 and 23 months. The WHO protocol developed by Henderson [9] for evaluating EPI immunization coverage was used; the same method was used in the DHS-III in 2001. With this method, to be accurate within 10% with a margin of error of 5% would require surveying 210 children per health area. For greater accuracy, we surveyed around 250 children per health area. In each health area, children were selected using a random sampling; sample size was proportional to the population size. For each child selected, information on the vaccination card and statements made by the person responsible for the child during an individual guided interview were noted. There is a discrepancy between data taken only from the vaccination cards and those based also on the mothers' statements. Thus, if we exclude the mother as a source of information, 4% of the children are considered to be only partially, rather than fully, vaccinated. The rate of fully vaccinated children thus becomes 26% instead of 30% [6].

Mothers' statements are subject to bias because they:

- might be subjected to historical biases;

- do not allow us to know if the vaccination was carried out at the right time;

- and therefore, do not allow us to properly study drop-outs.

In addition, illiterate mothers often cannot tell the difference between the EPI vaccinations and those of the NID, nor the differences among the various antigens.

Nevertheless, including them helps minimize the underestimation of immunization coverage that occurs because of lost vaccination cards. Given the biases related to the choice of one method over the other, it was decided to use the same definition as in the official reports of the DHS, which use both information from vaccination cards and mothers' declarations. Children were eligible if they had been residents for at least six months and if their parents consented to their participation in the study. Thirteen pairs of trained supervisors who spoke French well and at least one local language (Malinke, Khassonké, Bambara, Soninké, and Peul) carried out the interviews with the mothers using a questionnaire that was validated after pre-testing. Supervision was ensured by three physicians.

For each child, in addition to the data on the vaccination card, the following information was gathered: i) parents' knowledge about the diseases covered by the EPI; ii) dis-

tance from the health centre; iii) prenatal consultations and whether the mother was vaccinated against tetanus during pregnancy; and iv) socio-economic status, determined by the number of meals per day and whether the family possessed a radio and/or a television. Parents were also questioned about the reasons for non-vaccination or for dropping out between DTCP1 and DTCP3 (child having received DTCP1 but not DTCP3). Data collected on the questionnaires were coded and copied into Epi Info version 6 [10]. Analyses were carried out in SPSS version 12.0. The rate of immunization coverage was estimated as the proportion of children who had been fully vaccinated against the six diseases of the EPI, with a confidence level of 95% using the method of Fleiss [11] and a cluster effect of two [12]. Pearson's chi-square test was used to compare the proportions. Ratings ratios were calculated to assess the association between full immunization coverage and the other dimensions studied (parents' knowledge of EPI diseases, distance from health centre, prenatal consultations and mother's vaccination against tetanus during pregnancy, socio-economic status). A child is considered fully vaccinated if all EPI vaccines against the six targeted diseases were received.

Results

The numbers of children surveyed in each health area were: 252 in Djidjan, 250 in Fladougou, and 248 in Kasaro, for a total of 750 children, of whom 378 (50.4%) were male.

Proportion of children vaccinated, by antigen

Immunization coverages by antigen and by health area are presented in Table 1. Total immunization coverages for BCG, DTCP1, DTCP2, and DTCP3 were above 90%, while coverage for measles was 70.5%.

Proportion of children fully vaccinated

The immunization coverage levels observed are presented in Table 2. The rate of children fully vaccinated according to the mothers' declarations was highest in the Djidjan health area (78.2%), followed by Fladougou (76.4%) and Kasaro (67.7%). The rate of fully vaccinated children according to vaccination cards was highest in the Fladougou health area (63.2%), followed by Djidjan (58.3%) and Kasaro (58.1%). In the three health areas combined, the rate of fully vaccinated children according to the statements of those responsible for them was higher, at 74.1% [CI 95% (69.3–78.4)], than it was according to the vaccination cards, at 59.9% [CI 95% (54.7–64.8)].

DTCP1 to DTCP3 drop-out rate

If we rely on the vaccination cards held by the families, the rate of drop-out between DTCP1 and DTCP3 was significantly lower in Djidjan, at 2.8%, than in Fladougou (7.6%) and Kasaro (6%).

Table 1 - Proportion of children having received the various EPI antigens according to vaccination cards, by health area (2006).

	Djidjan (n= 252)	Fladougou (n= 250)	Kasaro (n= 248)	Total (n= 750)
BCG	92.1	92.0	91.5	91.9
DTCP1	96.4	98.4	92.3	95.7
DTCP2	95.6	93.2	90.7	93.2
DTCP3	94.1	92.4	87.1	91.2
Measles	69.4	74.8	67.3	70.5

Table 2 - Proportion of fully vaccinated children according to the mothers' declarations and the vaccination cards, by health area (2006).

	Statements			Vaccination card		
Health area	n	%	CI 95%	n	%	CI 95%
Djidjan	252	78.2	69.8–84.8	252	58.3	49.2–66.9
Fladougou	250	76.4	70.5–81.4	250	63.2	54.1–71.5
Kasaro	248	67.7	58.7–75.7	248	58.1	48.9–66.8
Total	750	74.1	69.3–78.4	750	59.9	54.7–64.8

Table 3 - Vaccination status and associated factors (2006).

Factors		n	% Fully vaccinated children	p
Mother's anti-tetanus vaccine	Yes	627	63.0	<0.001
	No	123	43.9	
Sex	Male	378	59.8	0.9
	Female	372	59.9	
Mother's education	Yes	111	65.8	0.16
	No	639	58.8	
Prenatal consultations	Yes	537	61.8	0.08
	No	213	54.9	
Knowledge about EPI diseases	Yes	57	61.4	0.8
	No	693	59.7	
Meals per day	1	82	56.1	0.46
	2-3	668	60.3	
Possession of radio	Yes	641	59.9	0.45
	No	109	59.6	
Possession of television	Yes	180	62.2	0.45
	No	570	59.1	
Distance from health centre	<6 km	330	45.9	0.35
	6–14 km	198	26.3	
	>14 km	222	27.8	

Factors associated with full vaccination

The associations between full vaccination and the factors studied are presented in Table 3. Among the factors studied, only the mother's vaccination status during pregnancy was associated with full vaccination of the

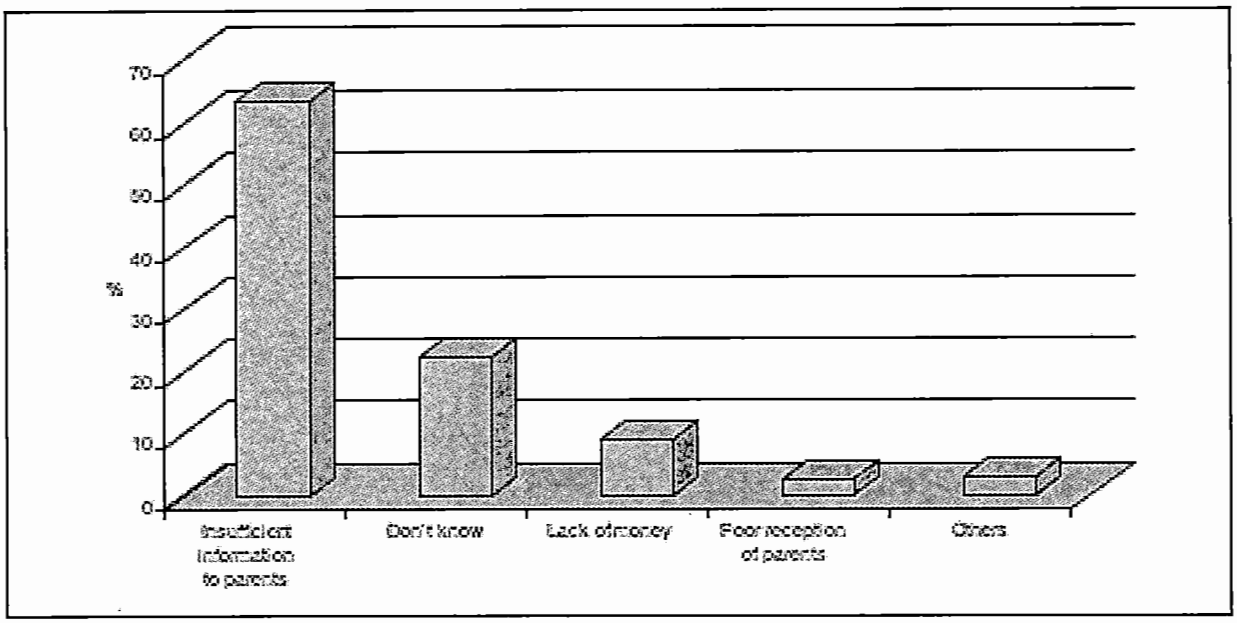

Figure 1 - Reasons for child's non-vaccination or dropping out, according to the mothers' declarations

child [OR=2.18, CI 95% (1.44–3.28)]. On the other hand, there was no link between full vaccination and the other factors, particularly the mother's education, prenatal consultations, parents' knowledge about the EPI diseases, the child's sex, distance from the health centre, or socio-economic status.

Reasons for non-vaccination and for dropping out according to those responsible for the children

The reasons for non-vaccination and for dropping out, according to those responsible for the children, are presented in Figure 1. The reason most often mentioned was insufficient information (63.3% of respondents), followed by a lack of money to buy the card or for travel (8.9%). Parents' refusal was mentioned by 4% of those responsible for children to explain non-vaccination or dropping out, while 2.4% cited unwelcoming reception and an overly long wait time.

Discussion

As shown in Tables 1 and 2, the rate of fully vaccinated children according to declarations of those responsible for them improved considerably between 2001 and 2006. Indeed, according to our study, this rate went from 13.6% in 2001 in the Kayes region to 74% in the three health areas of Kita. The studies carried out as part of the DHS-III in 2005 in the six communes of Bamako show rates of fully vaccinated children, according to the declarations of the person responsible for the child, ranging from 76.2% to 86.5% [13-18]. In Kita Circle, this increase in coverage can in part be explained by the fact that before 2003, a large part of the population (around 15%) lived between 15 and 100 km of the nearest vaccination centre, resulting in various transportation issues. Now, however, with the implementation of the priority program, the population lives within 15 km of a CSCom, and thus of vaccination centres. At the same time, it is also postulated that other aspects of the priority program, including the active search for missing children, contributed to this increase.

The rate of fully vaccinated children according to vaccination cards has also improved markedly between 2001 and 2006: going from 5% in 2001 in the Kayes region (according to the DHS-III) to 60% (according to our study). This rate was between 60% and 72.6% in the six communes of Bamako in 2005 [13-17].

According to the DHS-III in 2001 [8], immunization coverage was twice as great in urban settings, particularly in Bamako (52%), as in rural ones (24%). Our study, however, shows an increase in coverage rates in the three health areas of Kita Circle (all rural areas) to levels similar to those of Bamako. There is, therefore, a reduction of inequities in vaccination coverage between the rural zone of Kita and the capital city. Again, this increase in the vaccination coverage rate in the three health areas of Kita is likely linked to the priority program formulated and implemented in Kita Circle and financed mainly by GAVI. The lower rate for measles coverage is likely due to problems in the stock supply of measles vaccines in the region a few months prior to this study, as explained by the doctor in charge of the region.

Our study has also demonstrated that the probability that children will be vaccinated rises when the mother herself is vaccinated against tetanus, a finding that mirrors those of other authors [19,20]. We did not find any significant differences in rates of immunization coverage that could be related to the sex of the child or to the socio-economic status of the family, as reported in earlier studies [19,20]. In this case, the absence of any difference could be explained by the presence, as part of the priority program, of two intermediaries in each village who follow up on children who do not attend a vaccination session and plan for them to attend the following one, regardless of the children's sex or socio-economic status. It should be noted, however, that the fact that socio-economic status did not have any influence on vaccination coverage rates might be due to the inaccuracy of the indicators we used to measure socio-economic status.

While our initial hypothesis was that drop out rates were influenced by lack of money to pay for vaccination cards and poor reception by health personnel, the study showed that parents mention those reasons in less than 10% of drop-out cases, while they blame insufficient information 60% of the time. The observation that persons responsible for children most often mentioned insufficient information as the primary reason for non-vaccination or dropping out is not surprising and confirms the work of other authors [18,19,21,22]. However, these declarations contradict the other results of our study, which found that the level of knowledge of the EPI did not influence the vaccination coverage rate. These contradictory findings deserve a more detailed qualitative study in order to determine the real reasons behind non-vaccination or dropping out.

Figure 1 demonstrates that health personnel were held accountable for non-vaccination or dropping out in 2.4% of the cases in this study, particularly because of unwelcoming reception or overly long wait times. In other studies, the main reason given for dropping out was the long wait time [13-17]. In our questionnaire, however, we did not differentiate between reasons for non-vaccination and reasons for dropping out.

All the reasons provided for non-vaccination or dropping out underscore the need to give priority to providing information and raising the awareness of populations, even if earlier studies have demonstrated the limited efficacy of Information, Education, and Communication (IEC) sessions in health facilities [19,20]. However, the absence of any significant differences with respect to mother's education, prenatal consultations, parents' knowledge about the EPI diseases, child's sex, distance from the health centre, or socio-economic status is a reflection of the limitations of our study. These include: the insufficient strength of our sample; the lack of control groups; and the lack of an experimental design to actually evaluate the priority program.

If insufficient information is indeed confirmed to be a key factor in other contexts as well, further questions to be addressed by other studies could include:

- What are the factors that influence vaccination coverage in areas with active search for missing children versus those areas without it?

- What are the best strategies for raising awareness among illiterate people, to persuade them to have their children vaccinated without the need for the active search for missing children?

Among the eight circles of the Kayes region of Mali, our study looked only at Kita Circle. We selected Kita Circle because it had the lowest rates of immunization coverage in a region that, itself, had the lowest immunization coverage in the country. Even if there is no reason *a priori* to believe that immunization coverage in the other circles would be lower than in Kita Circle, it would be interesting to confirm this by an evaluation in one or more of these circles.

The increase in immunization coverage from 13.6% in 2001 in the whole region of Kayes to 74% in our study three years after implementation of the priority program demonstrates that it is possible, by using appropriate strategies, to significantly improve immunization coverage in the country. In this case, it would appear that decentralization of health activities has indeed contributed to an increase in coverage, but this needs to be coupled with the mobilization of appropriate resources (as was the case here with the support of GAVI) if objectives are to be attained.

Conclusions

Three years after the implementation of the priority program (which included decentralization, the active search for missing children, and deployment of health personnel, material and financial resources), our evaluation of the vaccination coverage rates shows that there is improvement in the EPI immunization coverage rate in Kita Circle. The design of our study did not, however, enable us to determine the extent to which different aspects of the program contributed to this increase in coverage. Efforts should nevertheless be continued, in order to reach the goal of 80% immunization coverage, and, as the study identified, notably through better information to parents.

List of abbreviations used

DHS-II – Demographic and Health Survey, 2nd edition; DTCP – Diphtheria, tetanus, pertussis, poliomyelitis;

DHS-III – Demographic and Health Survey, 3rd edition; IEC – Information, Education and Communication; WHO – World Health Organization; EPI – Expanded Program of Immunization; TV – Television; CI – Confidence interval; OR – Odds ratios; BCG – Bacillus Calmette-Guérin; GAVI – Global Alliance of Vaccines and Immunization.

Competing interests

They authors declare they have no competing interests.

Authors' contributions

AKK contributed to the design of the study, supervision of the surveys, and the writing of the manuscript; FS contributed to the supervision of the survey. IT, SD, KS, and KD participated in supervising the survey and writing the report. AM participated in writing the report. DT, FH, and AD contributed to writing the analysis and the manuscript.

Additional material

Additional file 1

Abstract in French.
Available from:
http://www.biomedcentral.com/content/supplementary/1472-698X-9-S1-S13-S1.doc

Acknowledgements

This work was carried out with the aid of a grant from the International Development Research Centre (IDRC), Ottawa, Canada, as part of the Canadian International Immunization Initiative Phase 2 (CIII2). This initiative is a project of the Global Health Research Initiative (GHRI). We wish to thank Slim Haddad, Pierre Fournier, and Marta Feletto of the *Centre de recherche de l'Université de Montréal* for their support to the conduct of this study, and Donna Riley for translation of the manuscript. We also thank the Kayes Regional Department of Health for their logistical and administrative support. We extend our gratitude to the parents of the children surveyed for participating in the study, and also to the local authorities for their support.

This article is published as part of *BMC International Health and Human Rights* Volume 9 Supplement 1, 2009: The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants. The full contents of the supplement are available online at http://www.biomedcentral.com/1472-698X/9?issue=S1.

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Determinants of parents' reticence toward vaccination in urban areas in Benin (West Africa)

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from The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants

Published: 14 October 2009

BMC International Health and Human Rights 2009, **9**(Suppl 1):S14 doi:10.1186/1472-698X-9-S1-S14

This article is available from: http://www.biomedcentral.com/1472-698X/9/S1/S14

Abstract

Background: Despite the efforts of health authorities, vaccination coverage of targeted child populations is still poor in many regions. Parents' reticence has been identified as one cause of this situation. However, there is little data to explain the phenomenon that could support decision-making.

Objective: The objective of the study was to uncover the determinants of this reticence toward vaccination among the religious population of the cities of Parakou and Cotonou in Benin.

Methods: This was an exploratory study using a qualitative survey of 12 pastors and 30 faithful from churches that are vaccination-reticent and a control group of the same number of faithful belonging to other churches, all Christian. Individual and group interviews were carried out in the local language using a pre-established and pre-tested guide. The data collected underwent discourse content analysis focused on specific themes.

Results: Analysis of the data reveals an erroneous perception of child vaccination. Those who are reticent say vaccination goes against the will of God, that it is a poison from the "white witch doctor", and that those who vaccinate their children are committing a sin. Members of the control group argued against this, but without conviction. They adhere to the principle of obedience to authority, a biblical precept invoked when the vaccinators oblige them to vaccinate their children. Other factors were identified that could explain the reticence, such as the tactlessness of the vaccinators, parents' previous experiences and false rumours about vaccination.

Conclusions: The reasons for reticence are mainly related to parents' beliefs in religious principles that are sometimes poorly understood. To limit the spread of this phenomenon, more detailed information and negotiation between the health authorities and the pastors of these churches are essential.

Abstract in French: See the full article online for a translation of this abstract in French.

Abstract in French

See Additional file 1 for a translation of the abstract to this article in French.

Background

African countries have experienced high infant mortality rates due to many infectious diseases that are avoidable through immunization. However, over the past several years, the vaccination of targeted child populations has reduced the risk of these deaths, thus making this intervention the highest priority for health authorities. Gaining control over the problems of vaccine supply, cold chain, and economic issues recently identified in urban settings [1] has resulted in improved immunization coverage that is, however, still not entirely adequate. This disparity in the protection of children is often due to certain parents' refusal to vaccinate their children [2], seen mainly among children whose parents are members of imported sects or religions. Such refusals are evidence of the reticence to vaccination found in many localities in Benin, most often in the cities. In fact, while opposition to vaccination may not be new among minority populations, its extension to all routine vaccinations on the basis of religious arguments has become worrisome for the effectiveness of the Expanded Program on Immunization (EPI). While the literature mentions the example of the Muslim states of Nigeria where parents accused the polio vaccines provided by UNICEF of being contaminated with sterilizing chemicals [3], there is little literature on non-vaccinated children of other religions.

Any upsurge in reticence presents a constant risk of resurgence in controllable infectious diseases. The lack of data on the perceptions of parents in these religions results in inadequate support for decision-making among health authorities.

How is it that, in the same Christian religion, some sects accept the vaccination of children and others oppose it? Why is vaccination rejected when vaccines are offered at no cost to all targeted children?

The aim of this study is to document the factors that lead parents in urban settings to adopt this reticent behaviour toward all vaccinations, in order to help limit the growth of this phenomenon and reduce disparities in immunization coverage among children.

Vaccination is an important strategy in pursuing the Millennium Development Goal of reducing high infant mortality in developing countries [4], and is an effective weapon in preventing and reducing disparities in life expectancy by lowering the incidence of deadly childhood illnesses. With the support of development partners, many African countries have made vaccination a high priority in the fight against poverty and have succeeded in increasing the immunization coverage of targeted populations [5].

Nevertheless, despite the efforts of health authorities, there has been a resurgence of measles epidemics in areas with low immunization coverage. The persistence of this and other vaccine-preventable diseases has raised questions about the determinants of this poor immunization coverage [6-8]. A recent study (Fourn L, Gansey R, Djego J: Equité d'accès aux soins et immunisation au Bénin. Rapport de recherche. Unité Internationale UdM/CRDI. 2005 [unpublished]) on equity of access and immunization in Benin highlighted economically poor areas and some religious sects that reject vaccination. The freedom enjoyed by religious sects in Africa has resulted in a multitude of imported religions [9] outside of the classic religions (Catholic, Protestant, Muslim). Once installed in a country, these sects spread gradually into bordering countries with their principles, beliefs, and practices. Over the past six years, the number of such sects has grown, predominantly in cities. In Benin, 10 or more have been identified in Cotonou and Parakou, and in some of these, the practice of child vaccination is forbidden, while the others appear to tolerate routine vaccination.

Parents' refusal of vaccination is not new in the literature, but the bases for this behaviour vary from one country to another. In France, for example, parents' reticence is expressed as reservations and doubts about the efficacy of certain vaccines. Thus, the current debate about the hepatitis B vaccine is so ingrained in this reasoning that, despite reassuring results from many studies, parents' reticence persists [10-13]. In Canada, the phenomenon of reticence is primarily marked by some parents' lack of conviction about the expected benefits of certain vaccines [14].

Many authors have investigated the underlying causes of poor immunization coverage in Africa, and the main factors mentioned have to do with adverse effects post-immunization and dysfunctional vaccination services [1,15]. Parents' religious beliefs are also impediments to the acceptance of routine vaccinations, depriving targeted children of the benefits of these preventive services. Moreover, disparities in immunization coverage within the same area raise questions about the causes of this situation, especially in urban settings where everything is done to provide services at no charge.

The literature provides very few studies on reticence, and these have looked primarily at the side effects of vaccinations and the perception of the risk to the community presented by non-vaccinated children. This perception varies depending on whether parents are educated or not [16]. Also, the sources of information about vaccination

play an important role in its acceptability among parents, who are very attentive to the sometimes negative rumours about vaccination. Because information directed at parents is not always consistent, some parents have erroneous information about vaccination [14,16]. This misinformation is often encountered in particular environments such as churches, neighbourhoods, and towns that are economically disadvantaged. The sustainability of immunization gains in most francophone African countries depends on controlling the emergence of this reticent behaviour as well as on the quality of services offered to children targeted by the vaccination program.

Methods

Study framework

Our survey was carried out in two cities: Parakou, in the north of Benin, close to Nigeria, and Cotonou, in the south. Parakou, the Department capital of Borgou, one of Benin's 12 departments, has a population of nearly 200,000 made up of many ethnic groups. There are approximately 27,000 children under the age of five, and the infant mortality rate is above 84%. Life expectancy at birth is 57.3 years. There is a variety of religious practices, chief among them Islam, followed by many Christian and other sects, of which some come from Ghana. The level of education is low, particularly among young women, mothers of the children targeted for vaccination. The dominant health issues are infectious and parasitic diseases, and the city has both public and private health establishments. Vaccination facilities and the organizing of outreach and fixed strategy sessions fall under the responsibility of the departmental authorities. Vaccination coverage is poor (55.9%), and the economic context is not encouraging.

Cotonou, a cosmopolitan city with a population of 800,000, is both Benin's economic capital and also the Department capital of Littoral. It has a high rate of educated females (63%). Life expectancy at birth is 60 years. The primarily business-oriented economic context is more advantageous to households that are relatively well-to-do than to the poor.

Besides the traditional religions (Catholic, Protestant, and Islamic), there are also many sects, some of which come from Ghana, Togo, and Central Africa. Membership in these sects can vary between 250 and 1,500 followers. The pastors of these sects are said to possess "charismatic healing" through prayer, and they recruit followers (whether educated or not) from various ethnicities. Some of these sects have a nearly military form of organization ruled by discipline and adherence to the pastor's words. Inspired by biblical scripture, some sects are reticent toward child vaccination, while others accept this measure for preventing infectious diseases.

Vaccination of targeted children in Cotonou is also free and is organized primarily using a fixed strategy, in both private and public health facilities.

Design

We carried out a descriptive exploratory study using a qualitative survey among the pastors of the churches (sects) that are reticent toward vaccination and of parents of targeted children, as well as control groups of pastors and church members from non-reticent sects. The study targeted certain Christian sects based on their number of followers, their variety, and the ease with which they propagate into the villages. The recruitment process was similar for both types of Christian sects (reticent and non-reticent).

In Parakou, we selected two vaccination-reticent sects from among the five in the city; these were selected non-randomly for their large numbers of followers (300 to 1,000). The pastors of these churches were recruited after two discussion sessions in which we obtained their consent. The pastors and their assistants who had agreed to participate in the survey (one pastor and two assistants for each church) were retained in the sample. The same approach was carried out with the non-reticent Christian sects to select six leaders who agreed to participate.

In Cotonou, the pastors agreed to participate and signed the consent document without conditions. The recruitment was done in the same way, with the same number of pastors and assistants in the vaccination-reticent and non-reticent groups. Altogether, 24 religious leaders in Parakou (n=12) and Cotonou (n=12) participated in the survey.

Through these meetings, we were able to obtain their authorization to interview members of their churches, who were advised of the presence of the surveyors at the Sunday church services preceding data collection. At the end of the church service, surveyors retained one member out of every 10 present at the service to be participants. This recruitment was carried out on three successive Sundays in the churches of the selected sects. We recruited 30 parents of targeted children in each of the reticent and non-reticent sects; ultimately, only mothers of children between the ages of 12 and 23 months were selected. Each was given a written consent form to read and sign, with a guarantee of confidentiality, anonymity, and the freedom to accept or decline to participate.

The approach used in Cotonou was the same as in Parakou, for both the leaders and the church members. Many church members refused to participate, and we were only able to recruit 26 mothers of EPI targeted children in reticent churches. The control group of 30 non-reticent church members was also selected from the

Christian churches whose followers vaccinate their children.

We conducted a descriptive, qualitative survey, carried out in each participant's home, away from the church premises. We used a single semi-structured, pre-established interview guide, for both religious leaders and church members, which included items about their perception and opinion of vaccination and about why this intervention might be considered unacceptable. We also assessed levels of education, where individuals were considered educated if they had completed four or five years of primary school and non-educated if they had received no formal education. The surveyors transcribed the interviewees' statements on paper during the course of the interviews.

The mothers who were interviewed individually also participated in focus groups to explore in greater depth certain points raised in the interviews.

Three focus groups were organized in Parakou with mothers of targeted children, two from the reticent sects and one from the non-reticent sect. The sessions were held at some distance from the other church members and the leaders, near the surrounding walls of the churches, with the authorization of the pastors. A team consisting of a facilitator (a sociologist experienced in group discussions), an observer, and an assistant carried out the sessions. Each was conducted in the local language and lasted about two hours, giving each mother time to share her thoughts. The group discussion guide included items on the perception of vaccination, opinions about reticence and the reasons underlying parents' reticence about vaccination.

In Cotonou, we conducted three focus groups under the same conditions as in Parakou with the interviewees from reticent sects. The non-reticent interviewees all refused to participate in the session, despite efforts by the team to persuade them.

In addition, in both Parakou and Cotonou, participants refused to have their statements recorded. We were required to take notes on paper; at the end of each session, the notes taken by the three session leaders were compared. Also, the pastors participated only in individual interviews carried out in their homes.

Content analysis was carried out after the statements from the focus groups and the individual responses were transcribed in French. We then compressed the data according to major themes emerging from the participants' statements to arrive at key messages.

Results

Sample characteristics

The sample of the reticent sects (churches) in Parakou consisted of a majority of men (16, or 53%); fewer than half of this faith group were educated (13, or 43%) and their average age was 30.4 ± 7.4 years. Most of the female faithful were non-educated. The dominant ethnicities were Lokpa and Fon. In Cotonou, the faithful we recruited were older (38.2 ± 10.8 years), and more than half (14, or 53%) were educated; 15 (57%) were men. The dominant ethnicities were Fon and Goun, spread across many sects.

The non-reticent faithful in Parakou were on average 34.1 (± 10.5) years old, and more than half were educated (20, or 67%). There was a variety of ethnicities, with none being dominant. In Cotonou, they were in the same age range of 31.4 ± 7.0 years, with 20 (77%) being educated. The majority (16, or 53%) were female (see Table 1).

The ages of the pastors in the reticent sects of the two cities ranged on average between 45 and 48 years, while the non-reticent pastors were apparently younger (35.7 to 40 years). They were all male, and few of the reticent pastors had completed secondary school. In contrast, of the non-reticent pastors, 10 (83%) in Cotonou had completed secondary school. They were of various ethnicities and were fluent in the local languages, which they used for preaching. They generally lived not far from their churches (see Table 2).

Perceptions of the pastors of reticent churches

Interviews with the pastors in both cities revealed a variety of perceptions, with no unanimously shared common ground. According to them, their churches' principles are founded on the idea that "God, protector of humankind, looks after all His faithful," who require only prayer to protect and heal them in times of illness.

It is undoubtedly the belief in the miraculous power of prayer that motivates some parents not to vaccinate their children. The pastors say that vaccinations make healthy children sick, alluding to potential adverse reactions to vaccines. They assert that vaccination is "a tool of the Devil" that will impede children's protection by God. Our observation was that these pastors do not understand the benefits of immunization, and thus instil in their followers a false understanding of vaccination, which they consider to be "something evil, a satanic practice aimed at leading the faithful away from the right path."

The faithful perceive vaccinating children against their parents' will to be a violation of the rights of both children and parents. They deplore that some vaccinators use the police to force them to vaccinate their children, and say that the vaccinators should leave parents free to make

Table 1 - Sample distribution of church members by their socio-demographic characteristics.

	Reticent		Non-reticent	
	Parakou (n=30)	Cotonou (n=26)	Parakou (n=30)	Cotonou (n=30)
Demographic				
Average age	30.0 ± 7.4*	38.2 ± 10.8	34.1 ± 10.5	31.4 ± 7.0
Males	16 (53%)	15 (57%)	16 (52%)	14 (47%)
Education				
0 years	17 (57%)	14 (54%)	10 (33%)	7 (23%)
1-4 years	10 (33%)	11 (42%)	5 (17%)	3 (10%)
≥5 years	3 (10%)	1 (04%)	15 (50%)	20 (67%)
Ethnicity				
Lokpa	15 (50%)	1 (3%)	–	–
Fon	8 (27%)	14 (54%)	20 (66%)	22 (73%)
Goun	24 (80%)	9 (34%)	6 (20%)	8 (26%)
Others	4 (14%)	2 (8%)	4 (14%)	1 (4%)
Churches (religions)				
Apostolic (Batingue, Truth, etc.)	14 (47%)	9 (30%)	3 (10%)	1 (3%)
Evangelical	9 (30%)	10 (38%)	9 (30%)	4 (12%)
Celestial Christian	3 (10%)	1 (3%)	3 (10%)	8 (26%)
Renaissance d'homme (Union Revival Church)	4 (14%)	7 (27%)	4 (13%)	15 (50%)
Church of the Redeemed	–	–	10 (33%)	2 (7%)

* Average age with chi-square.

Table 2 - Sample distribution of church leaders by their socio-demographic characteristics.

	Reticent		Non-reticent	
	Parakou (n=6)	Cotonou (n=6)	Parakou (n=6)	Cotonou (n=6)
Average age	45 ± 7.5*	48 ± 9.4	40 ± 10.0	35.7 ± 2.0
Males	6 (100%)	6 (100%)	6 (100%)	5 (83%)
Educated**	2(33%)	3(50%)	4(67%)	5(83%)
Catchment population	500-1500	300-800	1000-1500	1600-3000

* Average age with chi-square.
** Individuals were considered educated if they had completed 4-5 years of primary school.

their own choices, observing the tenets of their faith or biblical precepts. According to them, prayer is the only means of obtaining God's protection against illness.

Other leaders consider vaccines to be "poison" with which the vaccinators want to inoculate the children at any price; they see vaccinators as "distributors of poison and of sin." Church members who disobey instructions and have their children vaccinated provoke their pastor's anger and discontent. One pastor, in explaining this situation, said, "as soon as I find out this has happened, I punish these followers before the divine wrath comes down on them, because they are disobeying God."

Some pastors invoke biblical passages, whose content appears to be poorly understood, to justify their attitude toward health services, and especially vaccination. It is in this regard that the biblical passage from Isaiah, chapter 55, on the free blessings of God, is often cited.

Perceptions of pastors who are non-reticent toward vaccination

The discourse of non-reticent pastors on the acceptance of vaccination is ambiguous, especially when they suggest that each person has his or her own opinion on the question and that they do not impose theirs on their followers. They say they have their own children vaccinated in spite of themselves and that the faithful are free to have their children vaccinated or not, in obedience to the health authorities. This obedience is based on the biblical principle that "the faithful must obey authority." Their discourse does not appear particularly to promote vaccination; these pastors wait until the authorities or vaccination officers force them to accept this preventive intervention. This ambiguous position is clearly illustrated in a statement made by one of the pastors: "I respect the position of members of my church who refuse vaccination. We must remember that faith is manifested differently in each of us, even if we are in the same church, such that individual members of my church can have different positions."

These different statements come primarily from leaders who are uneducated and those with three to four years of schooling. The discourse of educated pastors (four to five years of primary schooling) is often contrary to that of the non-educated pastors. They have a positive appreciation of the benefits of vaccination and encourage vaccinators to take care of the children of the faithful who accept. They do not impose their ideology on the faithful, but suggest that vaccination constitutes "a form of man's management of the world." They accept that when the risk of physical illness is imminent, the faithful can protect themselves with medical services.

Religious perception of vaccination among the reticent

The perception of the reticent faithful is the same as that of their religious leaders. According to them, vaccination is against the will of God; vaccinating a child is like making a "deal with the Devil"; the act of vaccination is seen as "the work of the white witch doctor, contrary to biblical scriptures." The faithful of the churches in Cotonou declared without hesitation that vaccines are "poisons created by white people to harm us and to do experiments on us in giving us diseases."

Based on the principle that only God gives life and is responsible for protecting it against all diseases, the faithful are instructed to follow only God when faced with illness. "If we are with God, we must be only with God. We cannot mix things up: vaccination, herbal teas, talismans." They are convinced that vaccines make children sick. In one discussion group, a mother declared: "It is the vaccines that make our children sick: hot bodies, vomiting; I nearly lost my child because he was vaccinated by force the last time. His body became hot and he was vomiting."

Personality of the pastor

In some churches, pastors have persuaded their followers that they can obtain cures for them from all sorts of illness, because they are healers with power from God. These pastors do not advise their followers to use health care services, and many followers believe wholeheartedly in the authority and healing power of their pastor.

From various conversations, it appears the aspirations and personalities of the religious leaders constitute real barriers to vaccination and promote reticence. In their quest for success and fame as healers, some pastors perceive health centres to be their competitors and therefore will portray them negatively, using primarily religious arguments. Some have constructed a taboo (a social and a moral proscription) around vaccination; in Benin, a taboo is often an object that must not be touched or an idea that must not be questioned. To defy this interdiction entails sanctions and reprisals from those who guard the taboo.

Men and women, faced with a prohibition on vaccination

When men speak, they very often use a variety of citations to recall God's superiority. Women, on the other hand, refer to God as a superior being who must not be deceived and whose teachings must be respected. When the mothers of children targeted for vaccination spoke of God during the interviews, they often began with, "God doesn't like...", "God has forbidden...", "God said...", all of which may express their attachment to the directives of their religious leaders. Illustrations of this are: "God doesn't like things that are dirty, and your vaccines are dirty"; "God has ordered us to trust only Him. To use that which does not come from him to protect children is a sin."

Perception of the faithful who are non-reticent toward vaccination

For the non-reticent, the advantages of vaccination were easily seen with the encouragement of vaccination officers. Nevertheless, concerns were raised about the forms of vaccines.

The group discussions and interviews carried out among the members of the churches in Parakou brought out the fact that vaccinations go under two names, depending on the form of administration. Vaccination by injection is called "Sopu" ("pricked"), while the oral form is called "Lisou". In Cotonou, the injectable form, "Abahwè", administered in the arm, is recognized and appreciated by mothers. They insist that no vaccine can be given "by mouth", whereas "Abahwè" has been known to them for generations. This may explain why oral vaccination is resisted by mothers in certain localities.

The faithful in other churches also declared that vaccination is "a means of prevention that can help save children." They acknowledge that it plays an important role as a barrier against deadly childhood diseases. For other mothers, an effective vaccination is recognizable by the indelible scar it leaves behind, which is not the case for many vaccinations in the EPI.

Other identified deterrents to vaccination

In the localities of those who are reticent, church members with three to four years of schooling present the same arguments as those who are non-educated. In contrast, parents who completed primary school are more likely to be among the non-reticent.

Among all the deterrents mentioned, prior experience of vaccination seems to carry significant weight. Many mothers said that vaccination sessions involved bureaucratic hassles and resulted in expenses for travel and for medications, in cases of adverse effects.

False rumours about vaccination were mentioned to explain the reticent behaviour of some mothers, which undoubtedly arose from a lack of information. Thus, poorly informed mothers mistakenly attributed to vaccination the occurrence of anaemia, which is sometimes fatal. These are most certainly children with undetected anaemia who exhibit symptoms only after vaccination.

Other factors that incite some mothers to abstain from having their children vaccinated, even when they perceive the utility of it, include insufficient financial means to cover expenses and the family's fear of adverse reactions to the vaccination.

Behaviour of health officials as a deterrent to vaccination

Some mothers who belong to reticent churches, even though they are reticent, have nevertheless had an experience of vaccination, which they recounted. They expressed their assessment of the two vaccination strategies generally employed and mentioned prior experiences that were negatively coloured by the tactless behaviours and actions of health workers. They said they preferred the outreach strategy, where the vaccinators are kinder and take their work more seriously, in contrast to vaccination sessions at fixed health posts. Negative behaviours on the part of vaccinators do not encourage mothers to use vaccination services.

Discussion

Child vaccination remains an effective strategy against epidemics and a public health intervention with a good cost/benefit ratio [17]. However, coverage in some areas is still low, in spite of the efforts of vaccination teams. Recent studies have described the poor quality of vaccination services, with the constant stream of vaccine shortages, failures in asepsis with harmful consequences, and offensive behaviours on the part of vaccinators, all of which produce a negative reaction among parents in regard to immunization services in African countries [15,18]. In developed countries, the reticence observed arises from public dissatisfaction with information provided about vaccination and a desire to have more say in decisions. In France, for example, many parents express reservations and doubts about the efficacy of certain vaccines such as antigens against tuberculosis, measles, and mumps [16,19]. Their generally anti-establishment sentiments are furthered by the negative attitudes of some generalist physicians, a situation that encourages these parents in their rejection of vaccines of proven effectiveness. The situation was made worse by media reports on the risk of complications related to the measles vaccine and the risk of multiple sclerosis related to the hepatitis B vaccine [10,16]. Parents' reactions, denouncing these risks, raised doubts about the utility of vaccination.

The Nigerian study mentioned in the introduction to this paper described Muslim leaders' distrust of the poliomyelitis vaccine provided by UNICEF. They did not invoke Islamic belief in their refusal, but insisted the vaccine contained sterilizing products and accused the West of trying to rob them of their fertility [2,3]. In contrast, the present study focuses on religious belief among parents who belong to Christian sects as a factor in understanding the reticence toward vaccination.

Other studies have mentioned the religious dimension in explaining the low rate of immunization coverage, without going into detail [3,9,20]. However, the present survey of religious leaders and church members shows clearly the role played by religious factors in the occurrence and persistence of parents' vaccination-reticent behaviour. In their statements, parents insist on their belief, which is based on their own interpretation of biblical scripture. They see vaccination as the "white witch doctor's work" and not as a divine imperative. The term "witch doctor" designates a person with supernatural powers who has made a pact with the Devil. The white man has developed the vaccine, a product reputed to prevent diseases; yet only God has this power. By creating the vaccine, the white man has entered into competition with God and therefore must have made a pact with the Devil to acquire these supernatural powers.

Among the reticent pastors and the faithful, belief appears to be so strong that it has obliterated any difference between the faithful with up to three years of schooling and those who are non-educated (having never attended school). However, church-going parents and pastors who completed their primary education (four and more years) have a completely different behaviour; they acknowledge the benefits of vaccination for children's health and are generally not reticent.

The context within which the churches operate can also shed light on the decisions of the faithful with respect to vaccination. Indeed, the results of the survey show, among other things, that one difference between the non-reticent sects and those reticent toward vaccination is in the number of their members; the non-reticent sects have more followers than do those identified as vaccination-reticent. It may be that it is easier for a pastor to instil in a small number of followers his erroneous perception of vaccination and to impose this on them, than it would be with a larger number of people. Many parents of targeted children, and their pastors, demonstrated through their statements that their religious beliefs strongly prevented them from accepting vaccination against EPI diseases. Added to this is belief in the power of witchcraft practised by vaccinators and medical professionals, and especially by the white creators of vaccines. In developing a solution to reticence in the African and especially in the Beninois

context, we must take into account the representation of vaccination agents as persons who compete with God by using vaccines as protection against disease.

In addition, from the statements of those in charge of the non-reticent churches and having low levels of schooling, we note that their perceptions of vaccination are not based on confidence. However, out of respect for an authority that orders vaccination and offers it free of charge to all parents, they accept to have their children vaccinated. This respect for authority was not shared by the reticent parents.

Besides this religious dimension of reticence, other factors were highlighted, related to the behaviours of vaccinators, the experiences of mothers, and false rumours. Most of these factors have already been mentioned in the literature from industrialized countries, where the preferred response has been to provide parents with clear information [19]. Indeed, in these industrialized countries, vaccination has been the victim of its own success. Because vaccination has defeated many infectious diseases, mothers of small children no longer live with the reality of these killer diseases and so no longer fear them, and they have difficulty comprehending the persistence of these diseases in other countries or localities [14,20]. In Africa, the situation is even more complicated because of the religious dimension that underlies reticence toward all child vaccination, and it requires a new response that takes into account the perceptions of parents in child immunization programs. It is important to reassure them with a broader base of information to counteract unfounded rumours and alleviate fears. From the results of this study, we observe a gap with respect to vaccination between the usual public health risk management model and unanticipated population behaviours. As suggested in the literature [14,19,21], a new form of dialogue is needed among all the actors involved in vaccination. Peaceful negotiation with reticent parents and their religious leaders, using resource persons from the same religion to vaccinate their children, would help to limit the expansion of this behaviour. Promotional actions should be aimed at correcting the poor understanding of religious scripture and communicating the benefits of this preventive intervention. These are essential elements of any negotiation with the leaders of the sects, whose power undermines the benefits that are sought from the vaccination programs in sub-Saharan Africa. Without such negotiation, there is a significant risk of losing the previous gains of the EPI at a time when efforts and resources currently directed at funding vaccines in the southern countries may become diverted toward dealing with the current food crisis.

Despite these results some limitations to the study were noted, mainly a non-randomized sample selection that reduced the generalizability of the results and no country data available on vaccination reticence. We note in passing that this study's results have galvanized many health authorities to embark on the national EPI team's pastor sensitization program to improve vaccination coverage.

Conclusions

The reasons for reticence are mainly related to parents' beliefs in religious principles that are sometimes poorly understood. To limit the spread of this phenomenon, more detailed information and negotiation between the health authorities and the pastors of these churches are essential.

Competing interests

The authors declare they have no competing interests.

Authors' contributions

All authors participated in the interpretation of results and in the critical review of the paper.

Additional material

Additional file 1

Abstract in French.
Available from:
http://www.biomedcentral.com/content/supplementary/1472-698X-9-S1-S14-S1.doc

Acknowledgements

This work was carried out with the aid of a grant from the International Development Research Centre (IDRC), Ottawa, Canada, as part of the Canadian International Immunization Initiative Phase 2 (CIII2).This initiative is a project of the Global Health Research Initiative (GHRI). The authors wish to thank Donna Riley for translation of the manuscript.

This article is published as part of *BMC International Health and Human Rights* Volume 9 Supplement 1, 2009: The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants. The full contents of the supplement are available online at http://www.biomedcentral.com/1472-698X/9?issue=S1.

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BMC International Health and Human Rights

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System-level determinants of immunization coverage disparities among health districts in Burkina Faso: a multiple case study

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from The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants

Published: 14 October 2009

BMC International Health and Human Rights 2009, **9**(Suppl 1):S15 doi:10.1186/1472-698X-9-S1-S15

This article is available from: http://www.biomedcentral.com/1472-698X/9/S1/S15

Abstract

Background: Despite rapid and tangible progress in vaccine coverage and in premature mortality rates registered in sub-Saharan Africa, inequities to access remain firmly entrenched, large pockets of low vaccination coverage persist, and coverage often varies considerably across regions, districts, and health facilities' areas of responsibility. This paper focuses on system-related factors that can explain disparities in immunization coverage among districts in Burkina Faso.

Methods: A multiple-case study was conducted of six districts representative of different immunization trends and overall performance. A participative process that involved local experts and key actors led to a focus on key factors that could possibly determine the efficiency and efficacy of district vaccination services: occurrence of disease outbreaks and immunization days, overall district management performance, resources available for vaccination services, and institutional elements. The methodology, geared toward reconstructing the evolution of vaccine services performance from 2000 to 2006, is based on data from documents and from individual and group interviews in each of the six health districts. The process of interpreting results brought together the field personnel and the research team.

Results: The districts that perform best are those that assemble a set of favourable conditions. However, the leadership of the district medical officer (DMO) appears to be the main conduit and the rallying point for these conditions. Typically, strong leadership that is recognized by the field teams ensures smooth operation of the vaccination services, promotes the emergence of new initiatives and offers some protection against risks related to outbreaks of epidemics or supplementary activities that can hinder routine functioning. The same is true for the ability of nurse managers and their teams to cope with new situations (epidemics, shortages of certain stocks).

Conclusions: The discourse on factors that determine the performance or breakdown of local health care systems in lower and middle income countries remains largely concentrated on technocratic and financial considerations, targeting institutional reforms, availability of resources, or accessibility of health services. The leadership role of those responsible for the district, and more broadly, of those we label "the human factor", in the performance of local health care systems is mentioned only marginally. This study shows that strong and committed leadership promotes an effective mobilization of teams and creates the conditions for good performance in districts, even when they have only limited access to supports provided by external partners.

Abstract in French: See the full article online for a translation of this abstract in French.

Abstract in French

See Additional file 1 for a translation of the abstract to this article in French.

Background

Large-scale mobilization of the international community has helped improve immunization coverage and reduce vaccine-preventable mortality [1]. Progress has been rapid and tangible [2], particularly in sub-Saharan Africa, where national programs have greatly benefited from measures to reinforce the capacity for intervention [3]. However, inequities to access remain significant, large pockets of low vaccination coverage persist, and coverage varies considerably across regions [4], districts [3], and health facilities' catchment areas [5]. In Burkina Faso, the most recent national survey of vaccination coverage showed a 41 percentage point disparity (31%–72%) between health regions with the lowest and highest complete vaccine coverage rates and a 35 percentage point disparity (58%–93%) for diphtheria, tetanus, polio and pertussis vaccine (DTPP3). Heterogeneity is also found at the district level, where coverage can vary considerably among and even within districts. There were gaps of more than 50 percentage points between the extremes of the districts in Burkina Faso and an average gap of 28 percentage points between districts within regions.

This paper focuses on district-level factors that can explain these disparities. Thus far, much less attention has been paid to district-level factors than to "micro-level" factors that might determine the propensity to have children vaccinated, either in relation to the demand side (characteristics of families, mothers and children [6]), or the supply side (characteristics of services provided locally). For example, studies in Africa, southeast Asia, and South America [7-15] have shown that immunization services' utilization is related to the acceptability, accessibility, quality, and affordability of the services provided by the health facilities and front line staff. Low vaccination coverage has been associated with lack of continuity in services (vaccine shortages, staff absenteeism, and irregularly held immunization sessions and outreach activities), poor accessibility (charges for vaccines or cards, excessive travel distance, long waiting time, and language barriers), unsuitable immunization sessions (insufficient numbers, inconvenient sessions, inappropriate schedules, and late arrival of personnel), and dissatisfaction with providers' attitudes (unfriendly behaviours, limited information transmitted to mothers, and lack of compassion/concern about the child's health).

Beyond these locally determined influences, we know little about why some districts perform better than others. Indirect evidence suggests district performance is directly related to the availability of resources required for regular supplies [15], proper functioning of the cold chain [16], and service continuity. One survey suggests that territories' vaccine coverage improves as the density of health facilities increases [17]. High turnover of senior management staff [18], restricted staff mobility [13], poor inter-sectoral collaboration [19], and faulty service organization were presumed to be related to non-performing districts. Health districts' vaccine coverage performance has also been associated with their reactions to events requiring mobilization of local capacities that could divert health workers from routine activities. These events include disease outbreaks and immunization days (IDs), about which contradictory effects have been reported [5,6,13,20,21]. Finally, health personnel motivation and attitudes [19,22] and management leadership have been identified as factors affecting the sustainability and quality of health and immunization programs [9,13,19,22,23].

Suspected managerial breakdowns in the districts are also a key focus of the Reaching Every District (RED) approach proposed by WHO to improve vaccine coverage in low-coverage areas. The RED approach targets five immunization functions: regular outreach services; supportive supervision; community links with service delivery; monitoring and use of data for action; and improved management capacities [3,24]. Others also recommend developing new strategies to improve the performance of vaccination activities [25] and training all mid-level immunization program managers in supervisory techniques and management [26].

Can performance gaps between districts and process inefficiencies at the district level be explained ultimately by outside contingencies, poor choice of intervention strategies, inappropriate organizational modalities, or suboptimal resource allocation? The answers are not clear and, to our knowledge, no systematic approaches have been undertaken to identify the determinants of these disparities. Most of the literature is based on fragmented and limited evidence and examines factors associated with vaccine coverage in only one district of a country.

This paper presents the results of a study exploring district-related factors that may account for variations in district vaccine coverage in Burkina Faso. Six districts with contrasting outcomes participated in this study. Discussions with decision makers allowed us to preselect a number of district-related factors seen as potentially influential. Based on the literature review, the research team then translated these factors into seven research hypotheses. The first four, which are focused on resources, were that, *all else being equal, immunization coverage should be higher or moving forward in districts where:*

1. donor-supported projects provide resources for routine vaccination activities;
2. the creation of new health posts has improved service accessibility;
3. health posts meet the staffing standards;
4. there is no discontinuity in supplies, nor cold chain failures.

The remaining three hypotheses refer to circumstances that are management-focused:

5. the management has introduced immunization strategies to complement the usual EPI-recommended activities;
6. the team copes appropriately with events such as outbreaks and IDs that could disrupt routine activities;
7. the District Medical Officer (DMO) demonstrates a high level of dynamism and commitment.

Methods

Design

The study was based on a multiple-case study design [27]. As the organizing force for all immunization activities, the district was the main unit of analysis, each district being a case. The convenience sample was intended to illustrate the diversity of evolutions in vaccination coverage. Six contrasting cases were selected: three showing increasing rates of DTPP3 and measles coverage between 2000 and 2005, two whose rates stagnated during that time frame, and one recording decreasing coverage. The cases belong to six different health regions and represent a variety of economic and socio-political conditions.

Data collection

The cases were investigated by reviewing documents, consulting a wide array of key informants and local actors, and drawing on secondary data. Based on discussions with stakeholders and relevant literature, the research team identified potentially influential district-related factors that were subsequently reviewed and discussed with local actors. Two focus groups were held for this purpose in each district, one with the chief nurses of the primary health centres (PHCs) and another with the district medical office (DO) staff. Data related to district resources, activities, and service coverage were gathered from: i) the health information system; ii) documentary sources, such as various Ministry of Health departments' statistical reports and districts' action plans and activity reports; and iii) interviews with key informants (10–15 per district) such as DO staff, health personnel, and certain individuals who had served at the district and had since been reassigned. The indicators of vaccination coverage and the activity statistics regarding the utilization of various front line services (childbirth, antenatal visits, and curative visits) come from health statistics collated by district teams using health centres' activity registers. Documentary sources and interviews with district personnel allowed us to reconstruct the history of the presence of technical and financial partners (projects or activities financed by aid agencies or NGOs), of local vaccination strategies, or of meningitis epidemics (for further details see Table 1).

Analysis

The analyses used a qualitative approach based on a "pattern matching" system to compare the situation encountered against theoretical propositions derived from the hypotheses [27]. The analyses consisted of three phases. First, a qualitative time-series analysis was carried out in each case. Information from a variety of data sources was organized to highlight the temporal changes and unforeseen events observed over the dependent and independent variables' evolution. We examined each district's 2000–2005 trends in immunization coverage for DTPP3 and measles. We then compared historical trends for each independent variable with trends in DTPP3 and measles immunization coverage. In order to obtain a general overview of the evolution of the utilisation of front line services by the population, the analysis of the evolution of vaccination coverage was compared with that of antenatal consultations and of childbirths that occurred in the health facilities. The research team interpreted these trends, using mural graphs that summarized, for each case, the various data series and key events that occurred during the observation period. Simplified versions of these graphs are presented in the Results section.

In the second phase, cases were cross-analyzed, taking each hypothesis individually. This approach fed into the

Table 1 - Source of information and collected indicators, by independent variable.

Independent variables	Source	Indicators
Occurrence of epidemics	- Interviews with key informants	- Month and year; - Disease
Occurrence of immunization campaigns/days	- Interviews with key informants	- Month and year; - Antigen
Immunization strategies	- Interviews with key informants (DMO, person in charge of the EPI program, manager, etc.); - Supervision reports and EPI report	- % of health centers ensuring daily immunization services in fixed and outreach strategies; - % of PHCs with strategies for finding drop-outs; - % of PHCs ensuring the management of open flasks; - Involvement of other actors in immunization activities (NGOs, associations, social mobilization) and the nature of their involvement
Profile of DMO and relationship with his team	- Interviews with DMO and key informants, manager - Action plan; inventory reports; supervision reports; - Reports from Ministry of Health	- Composition of the DO team (number, skills, turnover); - Financial capacities of the DO (source and amount per year); - Rate of supervisory activities integrated with report; - Length of DMO term of office; - Rate of recurrence of meetings of the DMO with the DO staff and with PHCs' chief nurses; - Rate of printing of DO newsletter; - Relation of the district action plan to the micro-plans of PHCs
Financial and technical partners	- Interviews with DMO or key informants, person in charge of EPI, manager - DO reports and action plan	- Number of financial and technical partners in the district; - Extent of financial and in-kind aid; - EPI activities benefiting from partners' support; - Period of intervention
Geographic access (in km)	- Interview with DMO and key informants, person in charge of EPI, - District health statistics service - DO reports and action plans	- Number of PHCs; - Mean number of km to access the closest PHC; - % of population covered (served) in fixed strategy; - % of population served by enhanced outreach strategy
Incidence of PHCs meeting staffing standards	- Archives of the regional and district medical offices, action plans, and inventory reports - Interviews with DMO and key informants	- % of PHCs meeting staffing standards; - % of PHCs with running COGES (management committees); - % of COGES that balance their budgets; - Degree/extent of participation of COGES in activity planning, follow-up and evaluation; - Nature and level of financing of EPI activities by the COGES (i.e., district's autonomy in funding its EPI activities)
Vaccine supplies, cold chain functionality	- Interviews with DMO and key informants, person in charge of EPI, manager, PHC's chief nurse - DO reports and action plans	- Yearly budget for immunization (as for action plan, COGES and others); - Number of PHCs with functional motorbike; - Level/extent of equipment for cold chain; - Number of PHCs having experienced failures in vaccine supplies, cold chain, or means of transport and communication (month/year, length and nature of the event, number of PHCs affected)

interpretations by means of a replication process aimed at maximizing internal validity. Rather than literal replication, we favoured theoretical replication [27] to see whether predicted patterns were found across and within cases (whether, for example, repeated events—e.g. the replacement of a DMO, followed by the replacement of that replacement—would allow us to test a hypothesis several times during the observation period).

The final phase involved returning to the field to discuss the results with the vaccination teams who participated in the group interviews. One or two field visits per district were carried out. These discussions allowed us to validate and refine our interpretation.

Results

The first subsection below presents results from the single-case analyses. For each district (assigned fictitious names), trends in immunization coverage are compared with trends in those factors and events that are hypothesized to have influenced immunization coverage during the period of observation. Trends in the utilization rates

of antenatal consultations and outpatient visits are also considered as indicators of primary health care activity. The second subsection examines the results across the six cases from the perspective of the initial hypotheses. Drawing upon focus group discussions (FGDs), the third subsection introduces the key elements and arguments pertaining to DMO leadership.

Case studies

Case I: Koya district

Time-series analysis: In Koya, DTPP3 coverage increased from 78% (2000) to 94% (2005), maintaining immunization performances above the regional mean throughout the six-year period (with a comparative advantage of 10 to 26 percentage points). The evolution of coverage for both antigens is illustrated in the upper part of Figure 1, with their trends paralleling that of antenatal consultations. The lower part of Figure 1 illustrates historical trends and main events of the period for some key indicators accounting for the independent variables. The district experienced outbreaks of measles (2001), meningitis (2003), then measles again (2004), responding to each effectively with a campaign. The study period saw improved geographic access to the district's PHCs (from an average > 7 km to < 6 km) due to an increase in their numbers, from 23 to 30. In the first three years, only 10% to 13% of health centres met staffing standards, but this proportion increased steadily, reaching 60% in 2005. The district experienced regular disruptions in logistics, cold chain, and vaccine supplies. In 2001 and 2003, all PHCs were affected by a cold chain failure. However, the support of a few technical and financial partners (TFPs), who provided refrigerators, improved cold chain functionality. Between 2000 and 2005, two medical officers were in office, for three years each (Figure1). Both maintained the immunization strategy introduced before 2000 that included registering foreign children in border villages and, in agricultural and farmers' valleys, attracting people at markets, in order to control targeted foreign populations.

FGDs – main results: In focus groups, local actors attributed Koya's consistently strong immunization performance to the district's tradition of social mobilization, going back to the EPI's establishment. Such mobilization benefits from the attendance of the nomadic populations' chiefs and the village chiefs at immunization sessions to enlist the villagers' participation, and from the support of the high commissioner and previous DMOs. Mobilization not only makes the population more responsive to immunization, but also sets the groundwork for taking immunization seriously, which helps sustain such strategies. The focus groups considered the current DMO, in office since 2003, to be less committed and apparently resting on his predecessors' laurels.

Case II: Bougou district

Time-series analysis: In Bougou, DTPP3 coverage decreased slightly between 2000 and 2002, with an overall uptake of 50%. Coverage increased by 25 percentage points between 2002 and 2003, and 10 per year thereafter, reaching total coverage in 2005. Measles coverage fluctuated between 50% and 60% from 2000 to 2002 and gained 30 percentage points in the following three years (Figure 2). An increasing trend is also observed in antenatal care utilization rates starting in 2002.

The district experienced several outbreaks in this period, responding in each case with a campaign: one in 2000, two in 2001, and another in 2004. Six IDs against polio were conducted in 2005 (IDs are not shown in Figures). The DMO appointed in 2002 implemented a new immunization strategy in 2003, consisting of a reinforced outreach strategy to be applied to the whole district in the first 12 months, and then subsequently only to PHCs whose immunization performance was judged insufficient or unsatisfactory. The next DMO, appointed in 2004, had been his immediate collaborator and maintained this strategy. The proportion of PHCs meeting staffing standards remained below 65% until 2004, then increased by 10 percentage points in 2005. Vaccine supply and storage were increasingly effective over the six years under observation. Before 2003, supply shortages and cold chain failures had affected several vaccines and more than 50% of PHCs. The incidence of such disruptions decreased beginning in 2003, and in 2005 only one vaccine and two PHCs were affected. While the number of PHCs experiencing a vaccine refrigerator failure did not change, the failure duration decreased by more than half, to under two weeks after 2004. TFPs in the districts have mostly contributed to logistics by donating motorbikes (28) and refrigerators (13), greatly reducing logistics failures. Geographic accessibility was comparatively poor in 2002, with an average distance of 9.5 km to the closest PHC. Two more PHCs were opened in 2003 and three in 2004, lowering the average distance to 8.7 km. The district remains nonetheless quite difficult to access, with several areas very far away from health services.

FGDs – main results: The increasing trend in coverage observed from 2003 onwards corresponds to the prioritization of immunization by the DO team after a situational analysis commissioned by the DMO appointed in 2002 revealed unsatisfactory EPI indicators. The resulting immunization strategy, begun in 2003, was continued by his successor. The improved performance should be ascribed to both DMOs, since both gave EPI high priority in the district's agenda and established positive relationships with the DO team and with PHC chief nurses (records show regular team meetings and regular issuing of a bulletin).

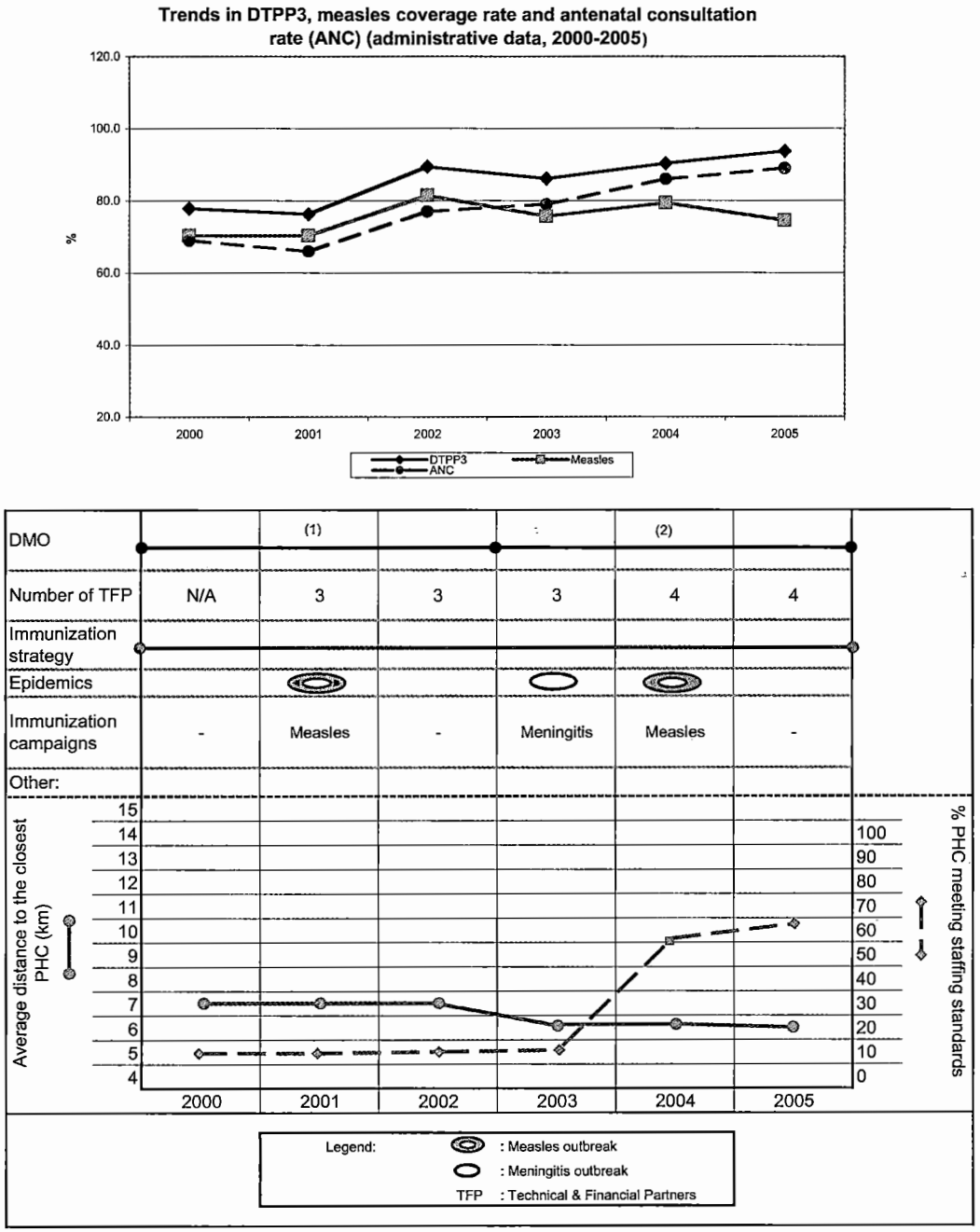

Figure 1 - Health district of Koya.

Case III: Mandé district

Time-series analysis: DTPP3 coverage fluctuated between 75% in 2000 and 65% in 2003 and increased steadily to 85% by 2005. Similarly, measles coverage fluctuated between 2000 and 2003 around an average of 65%, increasing to 73% in 2005 (Figure 3). The drops in both DTPP3 and measles coverage between 2001 and 2002, and the subsequent increases, are paralleled in the antenatal care utilization trend.

Mandé is characterized by relatively good geographic access, with no remote areas and comparatively low migration. The opening of three new PHCs in the six-year period halved the average distance to a health centre, from 10 to 5 km. The district experienced outbreaks in 2001 and 2004 and responded with campaigns. In each year under consideration, the district also implemented IDs; the greatest efforts were expended in 2004 and 2005, with nine and seven IDs, respectively.

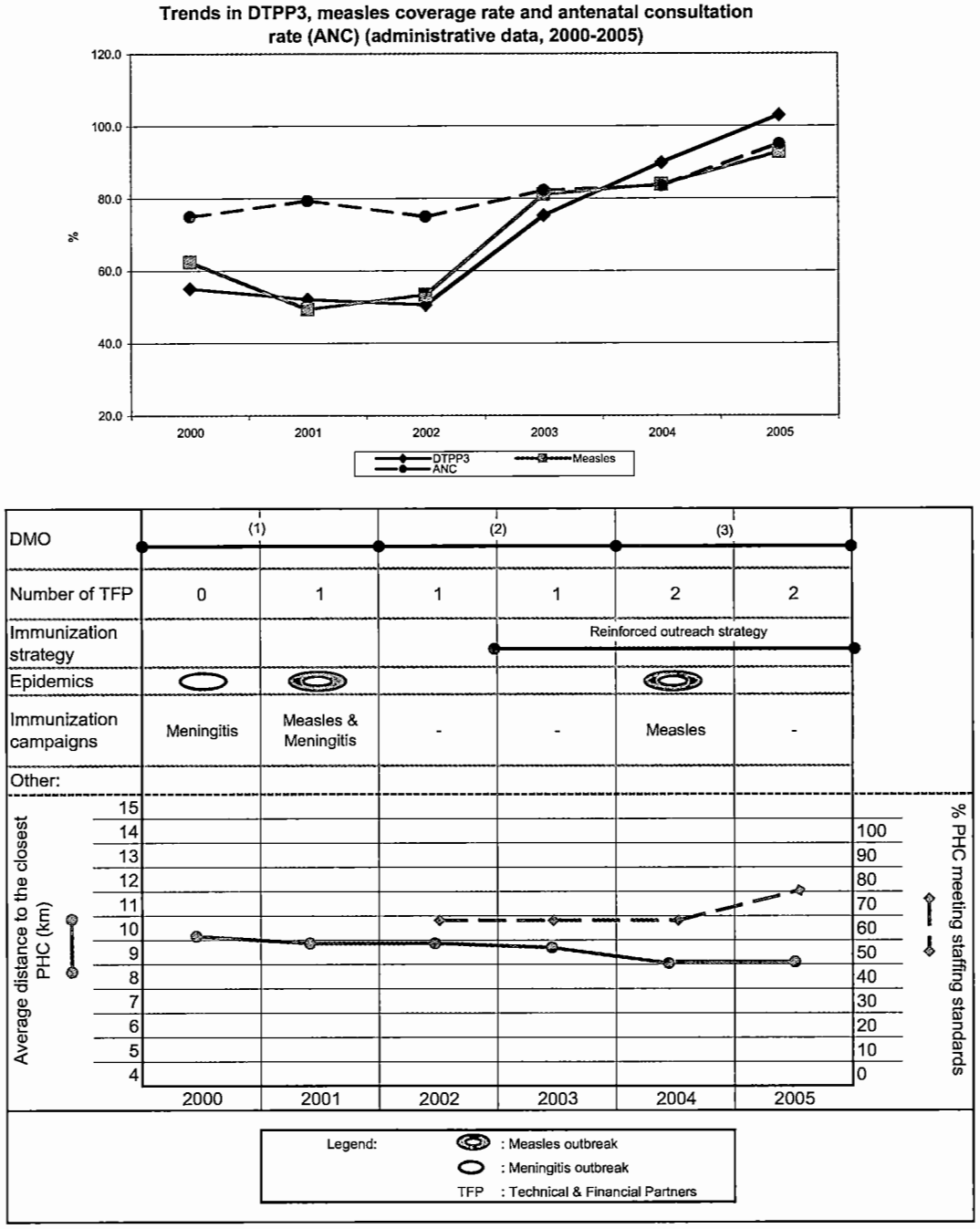

Figure 2 - Health district of Bougou.

Between 2002 and 2003, the PHCs' chief nurses protested (with sit-ins, strikes, activities boycotts, and local press) against the DMO, calling for his resignation on the grounds of bad management of the district's human, material, and financial resources. Many health workers also left, contributing to an already low and decreasing proportion of PHCs meeting staffing standards. In 2003, the DMO was replaced by the assistant DMO, who rapidly expanded activities and reinforced supervision of immunization activities in about half of the PHCs.

From 2000 to 2003, continuity in logistics and supplies had been very inadequate. Before 2003, less than 45% of PHCs were equipped with refrigerators and thus able to ensure the cold chain. Also before 2003, important shortages of syringes led to vaccination fees that discouraged

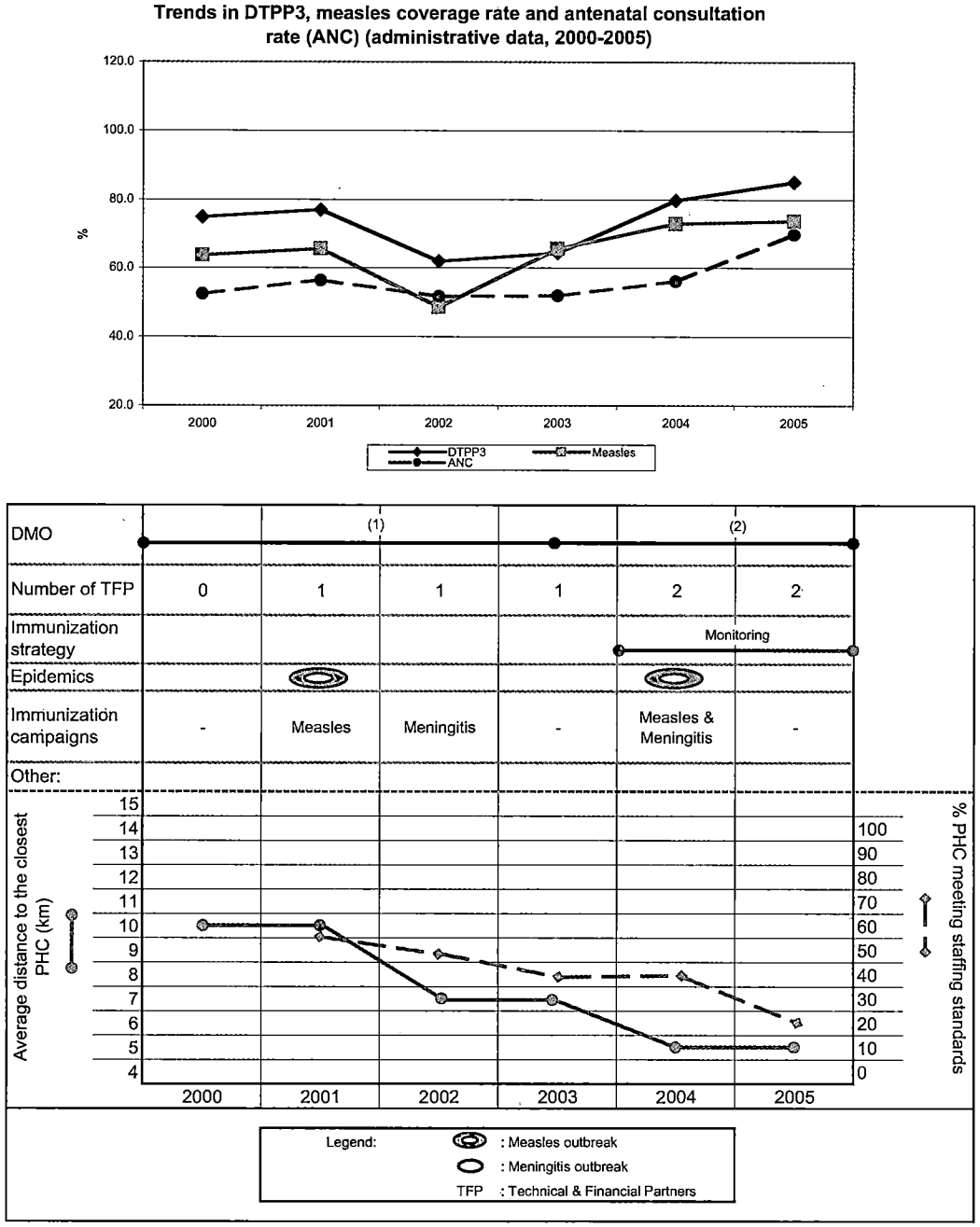

Figure 3 - Health district of Mandé.

mothers' participation in immunization sessions. In 2003, support from financial partners and a major contribution of supplies and equipment enabled more PHCs to ensure the cold chain (78% in 2004 and 91% in 2005), re-established the supply of syringes, and supported supervision.

FGDs – main results: With a shift in DMO leadership, the immunization coverage trend reversed direction. Local actors decried the former DMO's lack of transparency in managing resources, his abuse of authority, and his reliance on political connections to deflect criticisms. The district's action plan was not transmitted to the team, nor were consultation meetings held with PHC chiefs or the DO team. The report of the Immunization Cluster Survey carried out in Burkina Faso in 2003 was not shared with the collaborators. The working environment had deteriorated; there were protests calling for his removal, and

many workers left, thereby reducing human resources availability in the district. He was replaced in 2003 by his former assistant, who managed to restore staff confidence. She reinstated regular supervisions and consultation meetings, brought resources under better control, and significantly improved transparency in management. This led the Village Health Committee to increase its support to EPI from 4 to 10 million FCFA between 2003 and 2004, and the TFPs to allocate more resources to immunization activities.

Case IV: Dara district

Time-series analysis: In Dara, DTPP3 coverage progressed from 22% to 50% between 2000 and 2003, then jumped to 85% in 2004, and to over 100% in 2005. Measles coverage fluctuated in the first three years, then steadily increased to 81%. The district's performance remained below the regional average throughout the six-year period; however, the gap narrowed over time and immunization rates reached the regional average by 2005 (Figure 4). Utilization rates for antenatal care and outpatient visits also rose throughout the period, with a steeper incline starting in 2003.

In 2003, the DMO prioritized immunization, reinforcing the enhanced outreach strategy through an initiative specially geared to this district's low-density, scattered, and mobile population. Health personnel went door-to-door to identify children and vaccinate them according to their age bracket and immunization status. However, this was done only in the second semester of 2004. Financial support from foreign partners supported the initiative's implementation, as well as training in monitoring (in 2005) and logistical reinforcement (by 2005, all PHCs were equipped with motorbikes and refrigerators).

The opening of more PHCs over the six-year period improved geographic access from 15 to 12 km between 2000 and 2003, and to 11 km by 2005 (Figure 4). The proportion of PHCs meeting staffing standards decreased from 57% to 46%. Epidemics occurred in 2001 and 2003, and specific campaigns were undertaken.

FGDs – main results: A new DMO appointed in 2002, noting weak immunization performances, was able to mobilize the team in response. Records indicate more frequent DMO visits to PHCs after his arrival, as well as regular supervisions and statutory meetings. He developed an action plan and introduced a bonus for immunization agents.

The DMO's commitment and the resources injected into immunization starting in 2003 are reflected in an increase in coverage. While an undeniable improvement was observed, the extent of the increase is questionable. Local actors share the authors' concern about the validity of three-digit immunization numbers; however, because this district, being on the border, attracts users from outside the country, coverage rates as compiled by the information systems may indeed surpass 100%.

Case V: Dié district

Time-series analysis: Dié experienced two distinct trends in immunization coverage, with rates increasing between 2000 and 2003, then decreasing afterwards. Immunization performance has, however, been consistently below the regional average. The DTPP3 coverage rate went from 56% to 78% between 2000 and 2003, then back to 58% in 2005. The measles coverage rate rose from 58% to 75% in the first three years, and dropped back to 50% in 2005 (Figure 5). Utilization rates for antenatal care and outpatient visits also began to fall in 2004.

The district experienced four outbreaks in this six-year period: two of measles (2001, 2004) and two of meningitis (2001, 2003), each followed by campaigns. Moreover, one to three IDs targeting polio were carried out every year, then six in 2005. Increasing the number of PHCs over the six years from 22 to 28 reduced the average distance to the closest health centre from >11 km to <10 km. In the first few years, 100% of PHCs met staffing standards, but that proportion began to fall in 2003. Two of the most important disruptions in vaccine supplies occurred in 2002 and 2003. Over the six years, the district enjoyed the substantial support of several TFPs every year, three of which supported the EPI. Thus, the district's resources were significant and expanded over the years in the form of refrigerators, vaccines, equipment, and motorbikes, to mention a few. Partners had also supported the World Food Program (WFP) in the district, but this was interrupted in 2004 due to a shortage of food supplies. During the observation period, a reinforced outreach strategy was in place, introduced by the first DMO, who served until 2001; he was succeeded by an interim officer, who was confirmed in office in 2004.

FGDs – main results: Participants described the second DMO as authoritarian, poor at delegating, rarely present at the DO, scarcely communicative, and not engaged with his team, who had difficulty arranging meetings with him. Since 2002, that DMO had called less than 20% of statutory meetings with his team and none with the PHCs' chief nurses, resulting in a virtual absence of discussion and consultation. Those in charge of immunization activities were not included and were confined to an operational role. After his nomination in 2004, staff dissatisfaction led to departures that reduced human resources adequacy in PHCs. Members of the DO team said they missed the previous DMO (2000–2001), who had been active and productive, assertive and appreciative

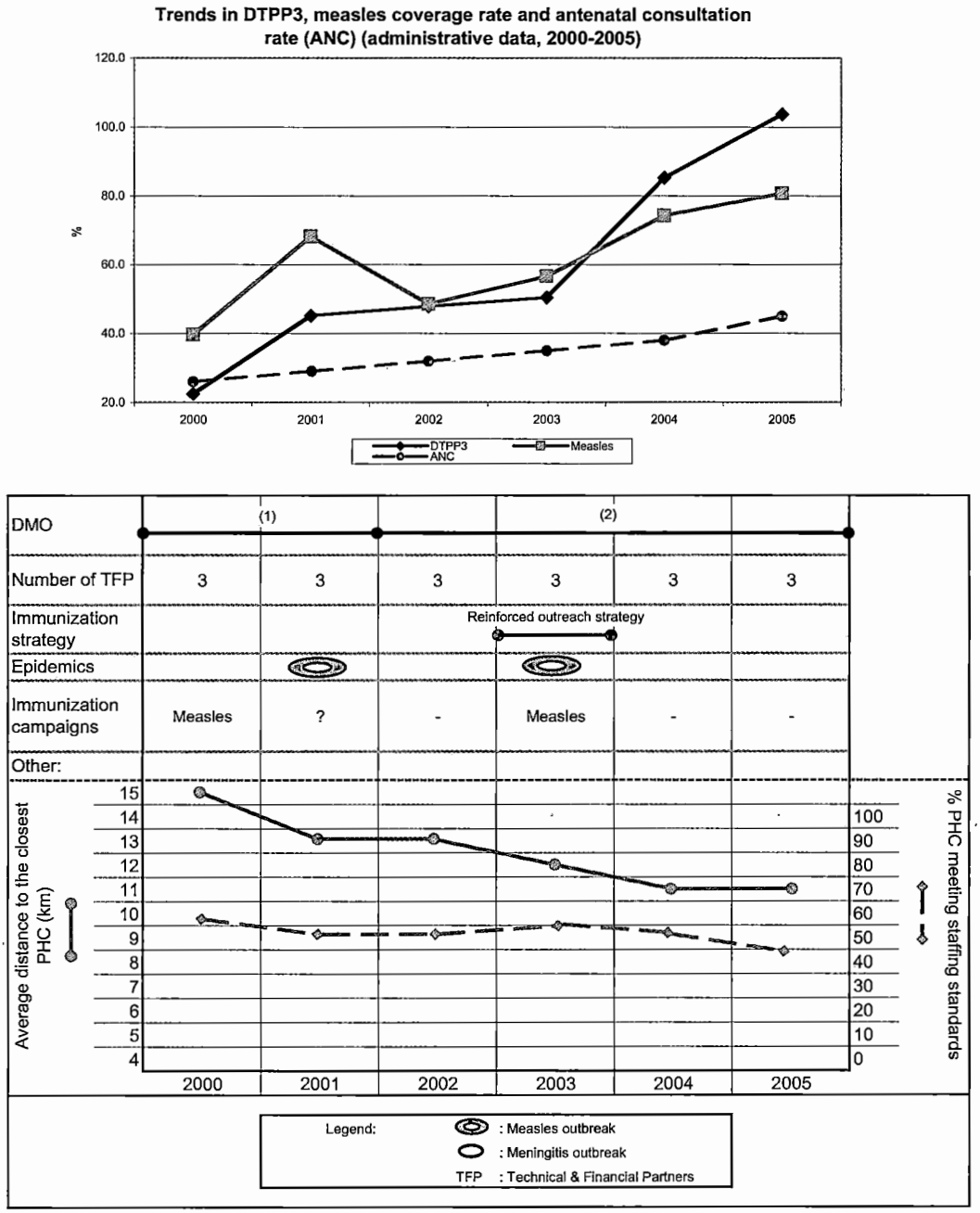

Figure 4 - Health district of Dara.

(sending appreciation letters to team members who did good work). During his mandate, team members had been assigned clear tasks.

Financial partners' substantial support positively affected immunization performance; some encouraged social mobilization for immunization through a program that provided food to mothers who brought their children to be vaccinated. According to local actors, this program's interruption in 2004 had a demobilizing impact on mothers and likely contributed to the steady fall in immunization performance.

Case VI: Boka district

Time-series analysis: Boka is in an accessible region with moderate seasonal population flows. This district registered high immunization performance over the whole period under observation, consistently over the national

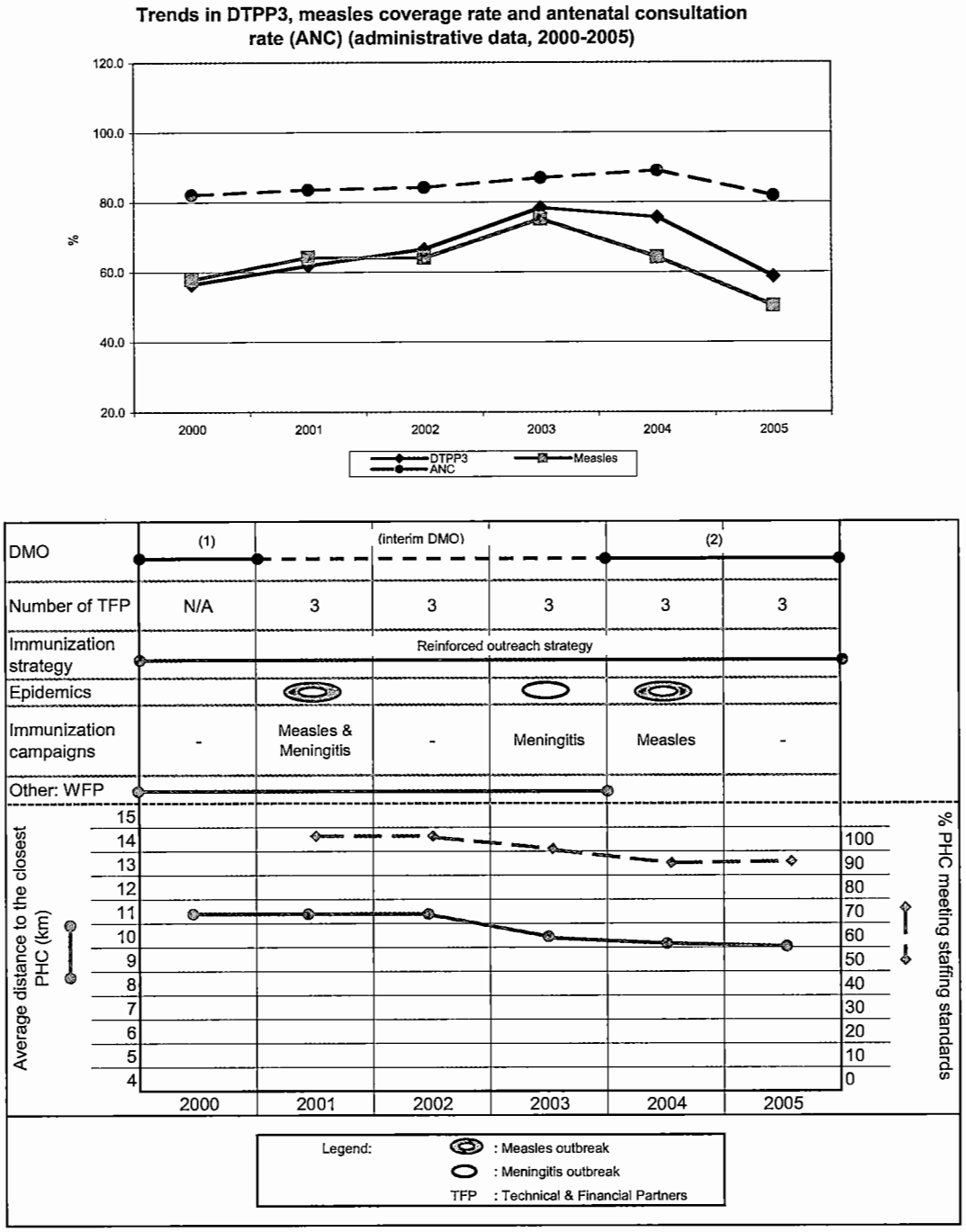

Figure 5 - Health district of Dié.

average (DTPP3 and measles coverage above 85% and 70%, respectively, since 2001) (Figure 6). Antenatal care and outpatient visits utilization rates were also consistently increasing.

Three DMOs served between 2000 and 2005. The last DMO, in office since 2003, introduced a census of children at the village level, continuously updated with the addition of newborns as well as incoming migrant children, in order to follow up on their immunization status. During the six years, no cold chain failure had occurred. All PHCs were equipped with motorbikes and refrigerators.. The district experienced outbreaks in 2001, 2002, and 2004 and organized several IDs—eight in 2004 and 10 in 2005.

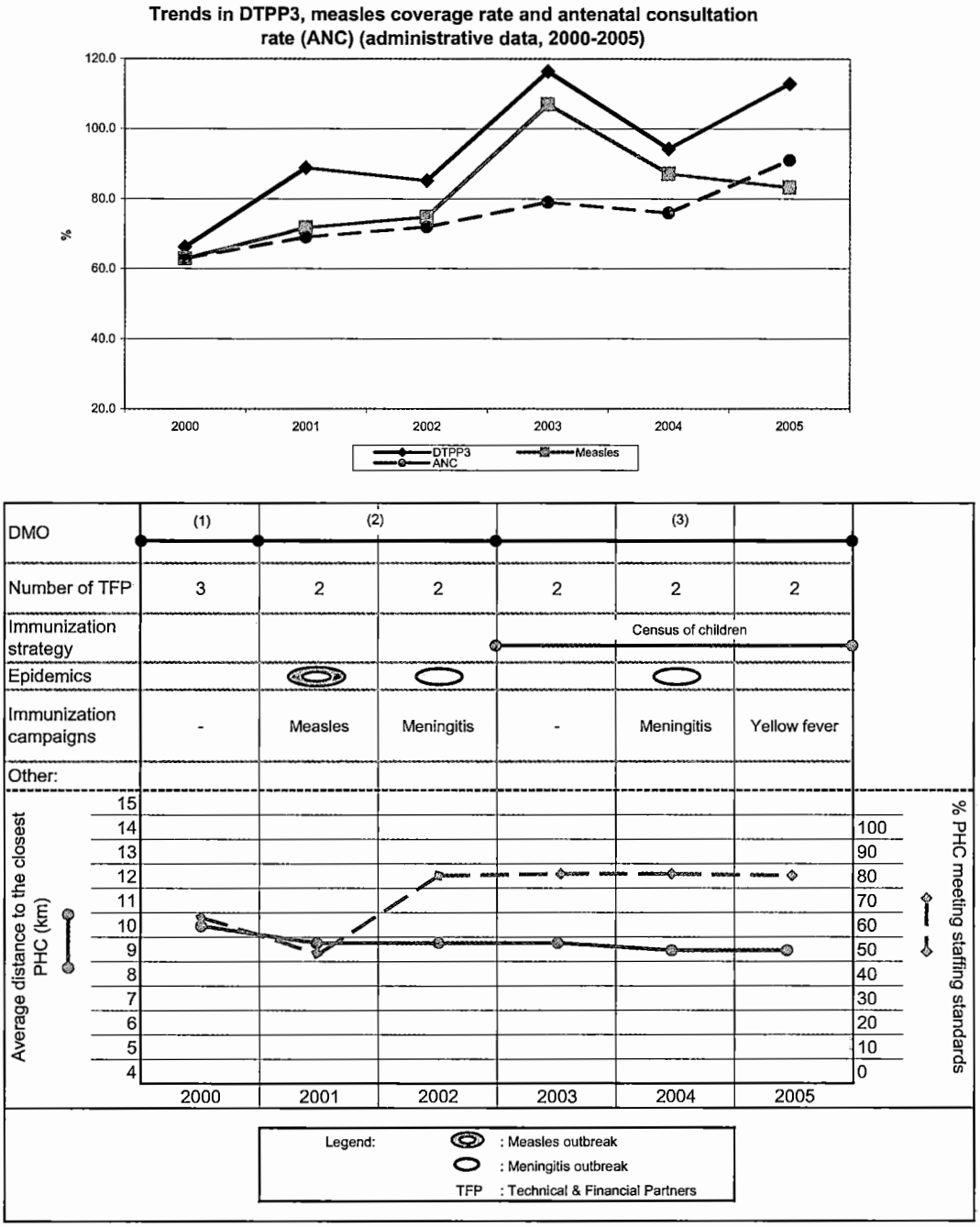

Figure 6 - Health district of Boka.

The district has enjoyed the support of partners which, although not numerous, have been quite stable in the district and have supported immunization activities.

FGDs – main results: In 2003 and 2004, this district attained almost complete coverage for both antigens. The district attracts clients from neighbouring districts, thus explaining the fact that coverage levels calculated on the basis of activity statistics exceed 100%. In focus groups, local actors considered the commitment and effectiveness of the latest DMO to be the determining factor. He introduced the child census and, most importantly, ensured rigorous follow-up of the enhanced outreach strategy, which included regular updating of the census register and strict adherence to the village visitation program. He also conducted four supervisions per year and regularly called

PHC chiefs on his cell phone to verify the observance of activities; when a planned visit was not respected, the nurse was required to prepare a narrative report. Local actors also noted how the DMO made use of TFPs' financial support for immunization to extend services and implement new strategies such as the children census.

Cross-case analysis

(1) Donor-supported projects: TFPs generally make it possible for districts to have essential resources for immunization such as vehicles and motorbikes for outreach visits, supplies, and a suitable cold chain. Some provide very specific support, as in the distribution of food in Dié which district officials consider to be a powerful inducement for women to attend vaccination sessions. However, our cross-case analyses show no unequivocal relation between the presence of a project or of external partners and district coverage performance. Even when TFPs provide significant support, performance does not appear to improve, except in districts where the DMO provides strong leadership and gives vaccination a high priority (as in Dié). Conversely, the presence of fewer TFPs does not seem to be a limiting factor in Bougou and Koya, where the EPI is a priority and DMO leadership is well established, and where everything unfolds as if the national resources (from the State, equity capital, and the Health Development Support Program) made it possible to provide adequate services. Interviews and observations in the Koya district also suggest that the TFPs' interest in funding activities in general, and those of the EPI in particular, might be related to how much collaboration there is between the local teams and foreign partners, and consequently also, to some extent, to the DMO's leadership.

(2) Geographic access: Several stakeholders expected the reduction in PHCs' catchment area radius to have a measurable positive impact on vaccine coverage, particularly for DTPP3, which requires several visits. The average radius is 9 km; in our sample, district radius ranged from 15 to 5 km. In Koya, where seven new centres were opened, and in Dara, where the catchment radius was substantially reduced (from 15 to 12 km), improved vaccine coverage might be explained by investment in new health facilities. However, in Dara, this increase can also be attributed to reinforced immunization strategies and the priority given to the EPI by district authorities. Prioritization by an effective leadership also explains the higher than national average immunization coverage in Boka, despite its radius being greater than the national average.

(3) Staffing standards: In Burkina Faso, the percentage of PHCs in a given district that meet the Ministry's staffing standard is used to estimate unmet needs. A full complement of staff enables districts to effectively implement vaccination activities such as outreach visits, react better to epidemics, and organize vaccination campaigns. This is why our respondents stressed the importance of this factor in explaining performance variations. In fact, however, our results did not support a clear association between staff levels and district performance over the years covered by the observation. In Dié we noted a steady decrease in vaccine coverage even though 90% of PHCs were fully staffed, whereas in Mandé vaccine coverage expanded while as little as 20% of PHCs had the required staff. It was the same in Koya, which, despite the low number of PHCs that met staffing norms, maintained high and steadily increasing levels of coverage between 2000 and 2003. The significantly improved human resources availability as of 2004 also had no apparent impact on vaccine coverage, which seemed to be holding steady.

(4) Logistics, cold chain failures: A significant improvement in logistics translates clearly, as in Mandé and Bougou, into improved vaccine coverage. In both cases, nonetheless, these improvements can also be attributed to district authorities' reinforcement of immunization strategies and TFPs' injection of resources into the EPI. Conversely, while all Koya's PHCs experienced cold chain failures in 2001 and 2003 that resulted in coverage setbacks, their amplitude was effectively contained through extended social mobilization.

(5) Local vaccination strategies: Beyond national immunization strategies, the vaccination performance of certain districts can be linked to their commitment to immunization and to how well they adapt their strategies to the district's context. These adaptations emerge either in response to an awareness of poor vaccine coverage that requires a specific response, or from the recognition that certain national approaches are not appropriate for the local context. They can take different forms: enhanced outreach strategies, social mobilization, monitoring or inventorying of vaccination targets. In Koya, social mobilization explains the steady, high coverage maintained despite adverse factors such as epidemics, frequent cold chain breakdowns, vaccine shortages, or staffing shortfalls. In this district, all activity indicators related to primary health care services and population coverage are at high levels, which helps to explain this sustained social mobilization. Moreover, in Bougou and Dara, the designation of the EPI as an action priority and the consequent development of new, context-adapted approaches are strongly linked with improvements in vaccination coverage. In both cases, the original idea and the implementation of these processes can be attributed to DMO leadership.

(6) Coping with unexpected events: (a) Outbreaks: At least two outbreaks of meningitis or measles were observed in each of the six districts during the period under consideration.

However, these had no measurable impact on those districts' annual vaccine coverage, and districts reacted to the outbreaks with campaigns or by intensifying vaccination activities targeting those specific diseases. *(b) Immunization days:* Several respondents worried that IDs not only diverted the districts' attention and resources, but also demotivated populations, particularly in their "door-to-door" activities that differ from those used in routine vaccination activities, which promote encounters between health personnel and members of the population at village gathering points. They saw this as a source of confusion for mothers about where to bring their children for routine immunization in the future. Other field staff are not bothered by the IDs, for which sessions are programmed in advance and inserted into their activity programs. In practice, neither IDs nor vaccination campaigns seem to have any measurable impact on the performance of routine vaccination services, even though we counted 9 and 10 campaigns in one year in Mandé and Boka, respectively.

(7) DMO leadership. An important result of our participatory approach for data analysis and validation was uncovering the key role of the human factor in explaining the levels, progression, and trend reversals in districts' immunization coverage. In the two districts—Mandé, in the first years of observation, and Dié—where the DMO's presence, motivation, charisma, and collaboration were judged to be poor, there was a considerable decline not only in vaccination performance, but also, significantly, in other indicators used to monitor primary care activities. Both cases reported poorly motivated staff, low levels of collaboration between the district teams and the PHCs' chief nurses, and no strategic direction defined by the district team, nor action priorities, nor targets for available resources to be implemented in the district. Conversely, districts whose leadership was considered to be strong and of high quality, such as Boka, displayed consistently high levels of immunization coverage. In the singular case of Koya, the observed consistently high levels appear to be attributable not so much to individual leadership, but more to the collective commitment to immunization of several community actors and officials (former DMOs included). In Mandé, Dara, and Bougou, changes in leadership appeared to reverse negative trends, inducing growth in coverage and in other activity indicators.

Evidence suggests that, in Boka and Dara, the DMO promoted locally-adapted initiatives (a child census and a door-to-door strategy, respectively) in contexts characterized by large mobile populations. These two cases suggest that strong leadership helps create the conditions that facilitate expanding coverage. In both districts, a change in leadership ultimately improved the synergy with local TFPs and resulted in expanded donor-based support for the districts' action plans. This, in turn, broadened the DMOs' latitude to reinforce or expand immunization strategies.

These cases also illustrate the DMOs' human resources management skills. In Boka, the DMO was able, through rigorous supervision and follow-up, to secure his team's commitment to sustaining the child census and to ensure smooth operation in a comparatively less accessible district. In Dara, the observed extended immunization coverage reflected the DMO's ability to obtain the greatest output from a level of staffing considered largely insufficient to the district's needs. In Mandé, the intensive efforts of nine and seven ID campaigns in 2004 and 2005, respectively, were handled appropriately by the district manager with no apparent impact on routine activities. In Koya, strong social mobilization appeared to counteract the consequences of supply shortages and logistic failures; despite cold chain failures that affected all PHCs in two different years, routine functioning was not impaired.

Discussion

Recent studies have advanced our understanding of system-related sources of disparities in coverage among countries, and of macro-level effects that are potentially attributable to human resources allocation [17], vaccine prices [6,28], decentralization [20], institutional performance [6], or aid received, whether technical or financial [2,3,28,29]. Given health districts' growing autonomy, this study is an attempt to contribute, with earlier studies [5,6,19], to better-developed factual bases to explain performance variations in vaccine coverage among districts of the same country, i.e., among territorial entities in comparable political, economic, and institutional environments. This process is all the more interesting because vaccine coverage is particularly sensitive to local health care systems' performance and constitutes a relevant marker of efficacy and good operation [15].

Four of the hypotheses refer to the potential impact of resource allocation on vaccination services efficacy and vaccine coverage progression. First, the results of our study show no unequivocal relation between the presence of a project or of external partners and the performance of districts in terms of coverage. TFPs, whether external aid organizations or cooperation projects, are currently present in nearly all the districts. However, their number, the scope of their interventions, and the types of support they provide vary considerably. Several comparative studies have demonstrated the impact on vaccine coverage of countries' access to transnational initiatives or to various forms of development aid [2,3,28,29]. Second, vaccine coverage is sensitive to district logistics, and, in particular, the cold chain. This is not surprising, given the extent to which immunization activities are contingent upon the

continuous availability of the vaccines. It confirms what has been largely demonstrated [15,16], including in Burkina Faso [8]. Third, immunization coverage did not change much in districts where geographic access improved during the period of observation. As in most prevention services, there is evidence that vaccination demand is sensitive to the efforts consumers must expend to receive the services, and vaccine coverage is closely linked with geographic accessibility [7,9,10,30]. While this study does not allow us to draw clear conclusions, we nevertheless believe this should not call into question the necessity of maintaining, as a matter of common sense, strategies for developing primary health care resources in both heavily populated and relatively remote areas, as well as outreach programs to cover geographically dispersed populations. Fourth, the level of staffing in the districts' health facilities was not a key determinant of the districts' performance. The results of our study do not correspond with the expectations of decision makers and field staff, who, as mentioned, tend to consider that inadequate staffing levels are an important constraint on activities. They are also inconsistent with the results of a large comparative study [17]. However, the results did not surprise the research team, for whom it is clear that the link between human resources availability and health system effectiveness in Burkina Faso is very tenuous at both the macro and micro levels [31,32].

Two hypotheses deal with the districts' ability to cope with destabilizing situations. Seasonal epidemics and IDs habitually mobilize an important part of the districts' resources and require considerable exertion, and it has been suggested they might negatively affect routine vaccination activities. On the whole, districts seemed to adapt well and were able to adjust their vaccination activities. The seasonal epidemics did not show a tangible impact. These results tally with those of the comparative analysis of 82 countries carried out by Gauri and Khaleghian [6]. This conclusion must nevertheless be qualified because examination of the evolution of coverage at the national level shows that national performance in vaccination may be sensitive to country-wide epidemics. It may be that districts' coping capacity is limited and dependent on national directives and on the scale of the epidemics, such that they are able to adapt when faced with episodes of low or medium scale. Finally, while the study introduces factual data into the current controversy on the potentially negative impacts of IDs on routine activities, it does not resolve it. Contrary to what has been reported in India [21] and Pakistan [13], for example, neither IDs nor vaccination campaigns seem to have any measurable impact on the performance of routine vaccination services.

The core finding of our study is the primordial role of the DMO's leadership in strengthening vaccine coverage performance. Our starting hypothesis, according to which the DMO's dynamism and commitment could positively influence the overall performance of vaccination teams and services, is verified. We also found that a strong and committed leadership promotes effective mobilization of teams and creates the conditions for good district performance, even when these districts have only limited access to support from external partners.

In Burkina Faso, leadership skills are not a criterion for a DMO's appointment, nor are they fostered as a part of an institutionalized supervision of the DMO under the health region's responsibility. The choice of DMO is made at the central level without clear, standardized criteria. As a consequence, a newly appointed DMO might have little experience or technical knowledge of management, and may scarcely be interested in public health matters. Supervision and training that should be assured by the regional medical office is generally lacking. Our results suggest that leadership skills should receive more attention when a DMO appointment is considered, as well as throughout a DMO's mandate, through adequate support and supervision.

Some studies show that immunization services and, more generally, the performance of health districts are linked to the professional and ethical practices [5,19,33,34], commitment, efforts, and motivation of health personnel [13,19,22]. Deficiencies in these qualities arise largely from poor managerial skills and inadequate leadership of the health districts [35]. However, the role of the human factor in local health care system performance remains largely unexplored; it is virtually absent in the technical and administrative institutional discourse and is usually totally obscured by decision makers and development agencies [35]. Preferred strategies such as the RED approach refer to them only indirectly, either in terms of improving governance [3,24] or strengthening the management capacities of mid-level managers [26]. Even if things seem to be slowly progressing, the discourse around factors that determine the performance or breakdown of local health care systems in lower and middle income countries (LMICs) remains largely concentrated on technocratic and financial considerations, targeting institutional reforms, resource availability, or health services accessibility.

Initially, the study was not planned to be an in-depth analysis of DMO leadership and neither the specification of study variables nor the analysis could have been based on a leadership framework developed *a priori*. It is therefore difficult to ascertain precisely and measurably the leadership qualities of the different DMOs who served in the six districts during the period under consideration, and this is definitely a limitation of our study.

Table 1 - Elements of leadership that could affect the performance of vaccination teams and services.

Qualities most often mentioned by field staff during focus groups were:
(1) Exercising authority: "leadership" authority, personality, charisma, ability "to keep on top of things"
(2) Managing teams: taking care to transmit and share information, listening, holding regular meetings, motivating staff, encouraging staff participation in decision-making
(3) Ability to create a good working environment
(4) Professionalism, voluntarism: able to analyze situations; volunteering; able to innovate and look for new solutions; undertaking new approaches; responding well to unanticipated situations; able to have his decisions recognized at the central and regional levels
(5) Diligence: being always present in the district
(6) Transparency in the management of resources

Empirically, from interviews with the field teams, the idea emerged that certain qualities of the DMO could play a key role in the performance of vaccination teams and services. These qualities are presented in Table 1. Given the limitations mentioned earlier, this list is provided for illustration purposes only, with no assumptions regarding its validity outside the context of this study. More in-depth studies are required to identify clearly the key elements of leadership in the context of managing district teams and to document the impacts, still not well understood, of the human factor on district performance.

Because of the relatively exploratory character of our approach and its setting in the reality of Burkina Faso, one limitation of the study is the extent to which the results may be generalized. Also, the local context and the participative process led us to concentrate on a relatively limited number of exogenous and endogenous factors to explain differences observed in the degree and progression of coverage in only six districts. Large-scale studies might make it possible to explore further the different mechanisms of causality and the means by which external environments, the human factor, available resources, and institutional elements determine the efficiency and efficacy of district vaccination services.

Conclusions

The key to success appears to reside in the districts' ability to assemble a set of favourable conditions in which the human factor might play a major role. But the importance of leadership should not overshadow the fact that bringing together these favourable conditions and, particularly, implementing initiatives that are district-specific and adapted to their realities, such as the enhanced outreach strategy or child census, require at least a minimal amount of financial and technical resources. Our results indicate that a district can get these resources either from redirecting the funding priorities for its action plan and reallocating its own resources (supplied by the central authorities), or else from TFPs. Our observations suggest, in particular, that a change of team and new district leadership could, as was recently seen in The Gambia, provide the impulse needed to create a more collaborative dynamic with local TFPs [35] and encourage them to provide even greater support to the district's action plans.

Two decades ago, when the primary health care model was becoming widely adopted, Simmonds [22] advocated for devoting more substantial efforts to strengthening leadership capacities and setting up appropriate incentive systems. These recommendations, too often ignored in the implementation of decentralization, remain very relevant today.

List of abbreviations used

DMO – District medical officer; DO – District medical office; RED – Reaching Every District; PHC – Primary health centres; DTPP3 – Diphtheria, tetanus, polio and pertussis vaccine; FGDs – Focus group discussions; ID – Immunization day; TFPs – Technical and financial partners; WFP – World Food Program; EPI – Expanded Program on Immunization; LMICs – Lower and middle income countries.

Competing interests

The authors declare they have no competing interests.

Authors' contributions

SH and AB are the principal co-authors and contributed equally to this work. They took part in every phase of the study and, as principal investigators, are responsible for the scientific aspects of this article. All the authors were involved in the preparation of the research project, the analyses, and the drafting of the article. MK and ET were responsible for relations with decisions makers and stakeholders. MF supervised the data analysis and the formulation of results. GC contributed to the literature review and data analysis. PF provided scientific support throughout the project. All authors provided feedback on, and made revisions to the manuscript.

Additional material

Additional file 1

Abstract in French.
Available from:
http://www.biomedcentral.com/content/supplementary/1472-698X-9-S1-S15-S1.doc

Acknowledgements

The authors wish, first of all, to thank the management teams of the six districts and the field vaccination teams who engaged themselves without hesitation in the preparation of the study, its execution and the interpretation of the results. The study would not have been possible without their commitment and support. The authors also wish to thank their collaborators and the health authorities, as well as Donna Riley, for translation of the manuscript. This work was carried out with the aid of a grant from the International Development Research Centre (IDRC), Ottawa, Canada, as part of the Canadian International Immunization Initiative Phase 2 (CIII2). This initiative is a project of the Global Health Research Initiative (GHRI).

This article is published as part of *BMC International Health and Human Rights* Volume 9 Supplement 1, 2009: The fallacy of coverage: uncovering disparities to improve immunization rates through evidence. The Canadian International Immunization Initiative Phase 2 (CIII2) Operational Research Grants. The full contents of the supplement are available online at http://www.biomedcentral.com/1472-698X/9?issue=S1.

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Translated Abstracts

Note from the Supplement Editors

The articles in this journal supplement all report on studies that were carried out in countries where English is not or is only one of the official languages. In an effort to increase the local relevance of the articles presented here, all authors were given the opportunity to translate their abstract into one of the local languages for it to be included in this journal supplement. This, it is hoped, will render the research more accessible to in-country study participants, health workers, service providers, researchers, and decision makers.

The following pages therefore present translated abstracts from eight of the journal supplement's 13 research articles (six in French, one in Russian, and one in Hindi). They are presented here in the same order as that of the full articles:

1) Corsi *et al.*: **Gender equity and age-appropriate immunization coverage in India from 1992 to 2006** [*in Hindi*].
2) Dugas *et al.*: **Portrait of a lengthy vaccination trajectory in Burkina Faso: from cultural acceptance of vaccines to actual immunization** [*in French*].
3) Sanou *et al.*: **Assessment of factors associated with complete immunization coverage in children aged 12-23 months: a cross-sectional study in Nouna district, Burkina Faso** [*in French*].
4) Djibuti *et al.*: **The impact of supportive supervision on the performance of national immunization program in Georgia** [*in Russian*].
5) Bicaba *et al.*: **Monitoring the performance of the Expanded Program on Immunization: the case of Burkina Faso** [*in French*].
6) Koumaré *et al.*: **Evaluation of immunization coverage within the Expanded Program on Immunization in Kita Circle, Mali: a cross-sectional survey** [*in French*].
7) Fourn *et al.*: **Determinants of parents' reticence toward vaccination in urban areas in Benin (West Africa)** [*in French*].
8) Haddad *et al.*: **System-level determinants of immunization coverage disparities among health districts in Burkina Faso: a multiple case study** [*in French*].

भारत में वर्ष 1992 से 2006 तक लैंगिक असमानता व आयु-उपयुक्त टीकाकरण कवरेज।

Daniel J. Corsi, Diego G. Bassani, Rajesh Kumar, Shally Awasthi, Raju Jotkar, Navkiran Kaur, Prabhat Jha

सारांश

पृष्ठभूमी

भारत में पुत्र पसंदता के परिणाम बाल मृत्यु दर, जन्म के समय लिंग अनुपात तथा स्वास्थ्य सेवाओं के उपयोग में पाए जाने वाले लैंगिक अंतरों में देखे गए हैं। विभिन्न प्रकार के अध्ययनों ने इन परिणामों पर विचार किया है । मगर पुत्र पसंदता के कारण टीकाकरण कवरेज में हो रही लैंगिक असमानताओं पर जो प्रभाव पड़ रहे हैं, उन पर बहुत कम अनुसंधान केंद्रित हुए हैं। इस बात पर भी ध्यान नहीं दिया जा रहा कि ये प्रभाव समय, क्षेत्रों के पार तथा सहोदर संघटन के अनुसार बदल गए हो सकते हैं। हम भारत में हो रही टीकाकरण कवरेज में रूझानों के व्यवस्थित परीक्षण को प्रस्तुत करते हैं जिनमें ध्यान का केन्द्र कवरेज में लैंगिक जन्म आदेश व राज्य के अनुसार आई असमानताओं पर होता है।

विधि

हमने वर्ष 1992 से 2006 के बीच में लगातार तीन बार हुए राष्ट्रीय परिवार स्वास्थ्य सर्वेक्षण के डेटा का विश्लेषण किया है। सम्पूर्ण टीकाकरण रिकार्ड सहित पाँच वर्ष से कम आयु के सभी बच्चों को इस विश्लेषण में शामिल किया गया था। आयु-उपयुक्त टीकाकरण कवरेज का निर्धारण निम्नलिखित प्रतिजनों के आधार पर किया गया था :-
बेसाइल कलमेट-गुरीन (बी.सी.जी.), ओरल पोलियो वैक्सीन (ओ.पी.वी.), डिफ्थीरिया, पर्टुसिस (काली खाँसी), टैटनस (डी.पी.टी.) तथा खसरा।

परिणाम

भारत में 1990 के दशक के शुरुआती दौर से टीकाकरण कवरेज में वृद्धि हुई है। लेकिन संपूर्ण, आयु-उपयुक्त कवरेज राष्ट्रीय स्तर पर अभी भी 50 प्रतिशत से कम है। तीनों सर्वेक्षणों के दौरान लड़कों के मुकाबले लड़कियों में बी.सी.जी., डी.पी.टी. तथा खसरे के लिए टीकाकरण कवरेज में उल्लेखनीय कमी पाई गई थी। इसके विपरीत ओ.पी.वी. की कवरेज में बढ़ोत्तरी, हाल ही के वर्षों में लैंगिक असमानताओं के सीमित हो रहे रूप को दर्शाती है। लड़कों के मुकाबले लड़कियों में प्रतिरक्षा करवाने की संभावना बहुत कम पाई गई थी, यदि उनकी बड़ी बहन जीवित थी । यह भी पाया गया कि सभी बच्चों में से बड़ी मात्रा में बच्चों का टीकाकरण सुझाए गए समय के बाद करवाया गया।

निष्कर्ष

टीकाकरण कवरेज में लैंगिक असमानताएँ आज भी भारत में एक समस्या के तौर पर बरकरार हैं। हमारे अध्ययन में टीकाकरण कवरेज में कमियाँ, टीकाकरण रूझानों में देरी तथा कवरेज में लैंगिक असमानताएँ पाई गई हैं। यह कमियाँ खास कर उच्चतर जन्म आदेश की लड़कियों में बाल मृत्युदर के खतरों को दर्शाती हैं, जिन्हें सामाजिक व कार्यक्रम स्तर पर संबोधित करने की ज़रुरत है।

Portrait d'un long parcours vaccinal au Burkina Faso : de l'acceptation culturelle à l'obtention des vaccins

Marylène Dugas, Eric Dubé, Bocar Kouyaté, Aboubakary Sanou, Gilles Bibeau

Résumé

Problématique

La grande popularité de la vaccination est sans doute liée au fait qu'elle a su démontrer par le passé qu'elle pouvait réduire de façon spectaculaire l'incidence des maladies évitables par la vaccination. Néanmoins, les positions face à la vaccination varient parmi les différentes communautés, affectant les taux de couverture vaccinale dans le monde. Diverses études, réalisées selon différentes perspectives, ont traité du phénomène de refus ou résistance active à la vaccination. Bien que, dans certains cas, la faible couverture vaccinale ait été bien expliquée par le refus ou la résistance active à la vaccination, on en sait peu sur les raisons de la faible couverture dans des régions où ces réactions sont absentes ou jouent un rôle mineur, en particulier en dehors d'un contexte épidémique. Cette étude tente d'expliquer cette situation dans le district sanitaire de Nouna au Burkina Faso.

Méthodes

Un travail approfondi de recherche ethnographique a été entrepris dans le district sanitaire de Nouna pour comprendre, d'un point de vue anthropologique, la logique qui organise le processus de prise de décision de la part des parents de faire vacciner ou non leurs enfants dans un contexte où le refus ou les réticences ne sont pas des barrières majeures à la vaccination.

Résultats

Trois éléments se sont dégagés de l'analyse : les conceptions empiriques des maladies de l'enfant, la perception de l'efficacité du vaccin et la connaissance de l'âge approprié pour la vaccination ; la différence entre la prise de décision en faveur de la vaccination et l'obtention réelle de la vaccination ; et, le parcours vaccinal menant à l'obtention de la vaccination dans le district sanitaire de Nouna.

Conclusions

Les procédures que les parents doivent suivre en vue d'obtenir la vaccination de leurs enfants paraissent trop complexes et contraignantes et, à certains égards, détonnent avec les systèmes de sens locaux et les idiomes de la détresse liée à la prévention des maladies de l'enfance et à la grossesse. Elles se présentent en rupture avec la matrice culturelle affectant le processus de prise de décision et les comportements en lien avec la vaccination. L'attention doit maintenant être portée sur différents éléments de promotion du vaccin, de logistique de distribution, de structure et aux procédures exigées pour l'obtention de la vaccination lors des sessions de vaccination de routine, lesquels limite la demande active de la vaccination.

Analyse des facteurs associés à la couverture vaccinale complète chez les enfants âgés de 12 à 23 moi: étude transversale à Nouna, Burkina Faso

Aboubakary Sanou, Seraphin Simboro, Bocar Kouyaté, Marylène Dugas, Janice Graham, Gilles Bibeau

Résumé

Problématique

Le Programme Élargi de Vaccination (PEV) reste encore perfectible. Dans des pays comme le Burkina Faso, la couverture vaccinale dans le district sanitaire de Nouna était en 2003 de 31,5% contre 52% au niveau national. Cette étude identifie les facteurs spécifiques liés au niveau de la couverture vaccinale dans le district sanitaire de Nouna en vue de proposer une stratégie d'amélioration de cette couverture dans ce district et dans d'autres districts aux conditions environnementales et sociales similaires.

Méthodes

Une étude transversale a été menée dans 41 communautés rurales et une zone semi urbaine. Les données se rapportent à 476 enfants âgés de 12 à 23 mois issus d'un échantillon représentatif de 489 enfants tirés de la base de données du Système de Surveillance Démographique (SSD) du Centre de Recherche en Santé de Nouna (CRSN). Une analyse du parcours de vaccination de ces enfants a été réalisée. Les relations entre le statut vaccinal et les variables socio-économiques et diverses variables contextuelles liées à leurs parents et aux ménages ont été analysées à l'aide des statistiques du Chi-carré, de la corrélation de Pearson et de la régression logistique.

Résultats

Le niveau de couverture vaccinale complète était de 50,2% (IC, 45.71; 54.69). La connaissance des parents de la valeur préventive de l'immunisation était positivement associée au statut de couverture vaccinale complète ($p= 0.03$) en milieu rural. Les enfants de parents ayant évoqué une perception d'un problème de communication autour de la vaccination avaient un plus faible taux de couverture vaccinale ($p <0.001$). Il n'y a pas de différence due à la distance à l'intérieur des villages eux-mêmes et entre les villages hors du site de la formation sanitaire. Les enfants des parents non scolarisés ont un meilleur taux de couverture vaccinale en zone rurale qu'en zone urbaine ($p. = 0.028$). Une bonne communication autour de l'immunisation et de l'importance de la carte de vaccination, ainsi que les facteurs économiques et religieux influencent le statut vaccinal des enfants.

Conclusions

Les sites de vaccination dans les zones rurales ont pour but de donner aux enfants une plus grande opportunité d'accès aux services de vaccination. Cependant, ces efforts sont souvent entravés par les mauvaises conditions économiques, le faible niveau des connaissances et de communication sur la vaccination. Une communication globale sur la vaccination pourrait améliorer les connaissances des populations sur le sujet. Il est tout de même important que les interventions locales prennent en compte les particularités religieuses et les moments de l'année présentant des difficultés économiques. Des approches spécifiques qui prennent en considération ces distinctions doivent être appliquées dans le milieu rural et en milieu urbain.

Роль Поддерживающей Супервизии для Результатов Программы Иммунизации – Рандомизированное Полевое Исследование в Грузии

Мамука Джибути, Георгий Готсадзе, Акаки Зоидзе, Георгий Матарадзе, Лора Исмеил, Джилиан Клеар Кохлер

Абстракт

Обоснование

Одним из основных барьеров для улучшения степени охвата иммунизацией, является человеческие ресурсы и менеджмент человеческих ресурсов. В Республике Грузия, стране где в последней декаде проводились широкомасштабные реформы здравоохранения, недавно была проведена интервенция с целью улучшения осуществления програмы иммунизации. Были проведены ряд измерений для удостоверения в том, что менеджеры иммунизации эффективно осуществляют свою активность посредством прямого, персонального регулярного контакта, для руководства, поддержки и помощи персоналу выбранного учреждения здравоохранения, с целью увеличить их компетентность в работе по иммунизации. Целью этого исследования было документировать эффективность «поддерживающей» супервизии для выполнения программ иммунизации на уровне районов Грузии.

Методы

Был использован дизайн пре-пост экспериментального исследования для количественной оценки. Данные брались из базисного и последующих опросов работников здравоохранения и менеджеров иммунизации 15 интервенционных и 15 контрольных районов. Эти данные дополнялись дискуссией фокус-группы Центра Общественного Здравоохранения и персонала учреждления здравоохранения.

Результаты

Результаты исследования показывают, что пакет интервенции вызвал ряд ожидаемых улучшений. Среди менеджеров иммунизаци, интервенция независимо содействовала улучшению знания поддерживающей супервизии и помогла удалению барьеров для самосовершенствования, таких как доступность ресурсов для супервайзера, отсутствие понимания работниками зхдравоохранения важности поддерживающей супервизии. Интервенция независимо способствовала относительным улучшениям результатов предоставления сервисов на уровне районов, таких как показатели потерь вакцины и степень охвата иммунизацией DPT-3. Отчетливый положительный сдвиг в результатах предоставления всех сервисов как в интервенционных, так и контрольных районов, может быть отнесен за счет общего улучшения доступности здравоохранения для населения в Грузии.

Выводы

Провайдерские интервенции, такие как поддерживающая супервизия, могут иметь независимый положительный эффект на индикаторы программ иммунизации. Следовательно, рекомендуется имплементировать поддерживающую супервизию в рамки национальных программ иммунизации в Грузии и других странах переходного периода с похожим институциональным устройством системы здравоохранения.

Suivi de la performance du Programme Élargi de Vaccination: le cas du Burkina Faso

Abel Bicaba, Slim Haddad, Moussa Kabore, Emile Taminy, Marta Feletto, Pierre Fournier

Résumé

Problématique

Le principal défi auquel sont confrontés les Programmes Élargis de Vaccination en général, et au Burkina Faso en particulier, réside dans leur capacité d'atteindre et maintenir des niveaux de couverture vaccinale à même d'assurer une protection efficace des enfants. Ce papier vise à démontrer que l'indicateur principal de suivi des programmes nationaux de vaccination qu'est la couverture vaccinale complète des enfants n'est pas suffisant pour évaluer adéquatement leur performance, et permettre d'identifier les stratégies à mettre en œuvre pour l'améliorer. D'autres aspects notamment le respect du calendrier vaccinal et l'efficacité des stratégies à rejoindre l'ensemble des enfants (ciblage) doivent êtres considérés pour rendre compte adéquatement des réalisations des programmes.

Méthodes

L'étude a été réalisée en utilisant des données d'enquêtes réalisées au Burkina Faso: les Enquêtes Démographiques et de Santé de 1993, 1998 et 2003, et l'Enquête Nationale de Couverture Vaccinale réalisée en 2003 suivant la méthode des grappes de l'OMS. Nous décrivons les niveaux de couverture vaccinale et leur évolution en fonction des indicateurs considérés.

Résultats

La performance des régions sanitaires n'est pas la même selon qu'on la juge sur la base du niveau de couverture vaccinale complète, ou du statut vaccinal des enfants n'ayant pas complété leur vaccination. Les régions sanitaires couvrent des réalités diverses et des efforts d'intensité substantiellement différente seraient requis pour rejoindre effectivement l'ensemble des populations cibles.

Conclusions

La prise de décision gagne à intégrer une triple perspective de la performance, considérant à la fois la couverture vaccinale complète, le respect du calendrier vaccinal (la couverture adéquate), et le statut des enfants non complètement vaccinés. Une telle démarche permet de mieux cibler les interventions. Elle fournit des informations sur la qualité et l'adéquation de la vaccination et rend compte des efforts requis pour atteindre les objectifs de couverture vaccinale complète.

Évaluation de la couverture vaccinale dans le cadre du Programme Élargi de Vaccination dans le cercle de Kita, Mali: une étude transversale.

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Résumé

Problématique

Le Programme Élargi de Vaccination (PEV), lancé au Mali en 1986, prévoyait d'atteindre en cinq ans une couverture vaccinale de 80% contre six maladies cibles (diphtérie, tétanos, coqueluche, poliomyélite, rougeole et tuberculose). L'Enquête Démographique et de Santé (EDS) de 2001 révèle qu'à peine 13% des enfants âgés de 12 à 23 mois du cercle de Kita, dans la région de Kayes, avaient été complètement vaccinés contre les six maladies du PEV. Un programme prioritaire y a été introduit en 2003 par le Département sanitaire régional afin d'améliorer la couverture vaccinale dans la région.

Méthodes

L'étude repose sur une enquête de couverture vaccinale réalisée en juillet 2006 auprès des enfants âgés de 12 à 23 mois dans le cercle de Kita. Elle repose sur la méthode d'Henderson, utilisée notamment pour les EDS. La couverture vaccinale a été estimée à partir des carnets de vaccination et des déclarations des mères (dans le cas où la mère ne pourrait faire la déclaration, elle est faite par la personne en charge de l'enfant).

Résultats

La couverture vaccinale complète estimée est de 59.9% (54.7–64.8) sur la base des carnets de vaccination, et de 74% si on se fie aux déclarations des mères (69.3–78.4). Le taux de déperdition entre DTCP1 et DTCP3 est en nette diminution, à 5.5% selon les cartes de vaccination. La couverture est plus élevée chez les enfants dont la mère avait reçu une vaccination antitétanique [OR = 2.1, (1.44–3.28)]. Les connaissances des parents des maladies évitables par la vaccination, leur niveau socio-économique ou la distance entre le domicile et le centre de santé ne sont pas associés significativement à la couverture. Le manque d'information est par contre une des raisons évoquées par les parents pour expliquer pourquoi les enfants ne sont pas vaccinés contre les six maladies du PEV.

Conclusions

Trois ans après l'implantation du programme (qui incluait la décentralisation, la recherche active des enfants non vaccinés, et le déploiement de personnel de santé et de ressources matérielles et financières), on assiste à une nette progression de la couverture vaccinale. Les autorités locales doivent tout de même maintenir leurs efforts pour atteindre les objectifs nationaux de couverture qui ne sont pas encore rejoints.

Déterminants de la réticence des parents face à la vaccination dans les régions urbaines du Bénin (Afrique de l'Ouest).

Léonard Fourn, Slim Haddad, Pierre Fournier, Roméo Gansey

Résumé

Problématique
Malgré les efforts des autorités sanitaires, la couverture vaccinale des enfants cibles est encore faible dans plusieurs localités du Bénin. La réticence des parents à faire vacciner leurs enfants a été identifiée comme une des causes de cette situation. On ne dispose toutefois pas de bases factuelles permettant de mesurer l'ampleur et les effets du phénomène.

Objectif
L'objectif de l'étude était d'identifier les facteurs déterminants les comportements de réticence à la vaccination parmi des groupes religieux des deux principales concentrations urbaines du pays (Cotonou et Parakou).

Méthodes
L'étude repose sur une méthodologie qualitative. Des entrevues et des groupes focalisés de discussion ont été réalisés avec 12 pasteurs et 30 fidèles appartenant à des églises chrétiennes incitant les parents à ne pas vacciner leurs enfants. Un groupe témoin a été constitué d'un même effectif de fidèles appartenant à des églises n'étant pas défavorables à la vaccination. Les discussions ont eu lieu en langue locale après test des guides d'entrevue. Les analyses de contenu des discours ont été réalisées sur des thématiques précises.

Résultats
L'analyse des données révèle une perception erronée de la vaccination. Ceux qui s'opposent à la vaccination avancent que le vaccin est un acte non prescrit par Dieu ou transgressant les volontés divines. D'autres indiquent que c'est un poison du « sorcier blanc ». Ces justifications ne se retrouvent pas dans le groupe témoin, mais plusieurs semblent vacciner leurs enfants sans grande conviction, et cèdent aux infirmiers vaccinateurs au titre de leur respect de l'autorité. D'autres facteurs que religieux expliquent aussi la réticence : l'indélicatesse des vaccinateurs, l'expérience antérieure des parents, et la présence de fausses rumeurs concernant la vaccination.

Conclusions
La réticence s'explique principalement par les croyances et les interdits religieux véhiculés par les églises locales. Pour enrayer ce phénomène, une meilleure information est requise et les autorités sanitaires doivent entrer en négociation avec les pasteurs des églises défavorables à la vaccination.

Déterminants systémiques des disparités de couverture vaccinale entre districts sanitaires du Burkina Faso : une étude de cas multiple.

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Résumé

Problématique

Malgré les progrès rapides et tangibles dans la couverture vaccinale et la mortalité évitable par la vaccination enregistrés en Afrique subsaharienne, de larges poches de faible couverture vaccinale persistent et les iniquités d'accès à la vaccination demeurent tangibles. De fortes disparités persistent entre régions, entre districts, et au sein de mêmes districts entre les aires de responsabilités des formations sanitaires. Cet article s'intéresse aux facteurs propres aux systèmes de santé qui, au Burkina Faso, expliquent les disparités de couverture entre districts.

Méthodes

L'étude repose sur une étude de cas multiple réalisée dans six districts présentant des niveaux de performance et des profils d'évolution de la couverture vaccinale différents. Des études préparatoires et un processus participatif associant des informateurs-clé ont conduit à l'identification d'un ensemble de facteurs systémiques susceptibles d'expliquer l'efficacité des activités de vaccination dans les districts : la survenue d'épidémies et la conduite de journées nationales de vaccination, la performance du management, les ressources disponibles pour la réalisation des activités de vaccination, et des composantes institutionnelles. La méthodologie, axée vers la reconstruction de l'évolution de la performance des services de vaccination de 2000 à 2006, est basée sur divers documents et des entrevues individuelles et de groupe dans chacun des six districts. Le processus d'analyse des données a inclus l'équipe de recherche ainsi que les équipes de terrain.

Résultats

Les résultats suggèrent que les districts les plus performants sont ceux qui réunissent un ensemble de conditions favorables. Mais le leadership du Médecin chef de District (MCD) semble constituer la porte d'entrée principale et le facteur rassembleur de ces conditions favorables. Typiquement, un leadership fort et reconnu par les équipes de terrain assure le bon fonctionnement des services de vaccination, favorise l'émergence d'initiatives nouvelles en faveur de la vaccination et les protège, en quelque sorte, contre les risques inhérents à la survenue d'épidémies ou d'activités surajoutées pouvant nuire à la conduite des activités de routine. Il en est de même pour la capacité des infirmiers chefs de poste et leur équipe à s'adapter aux situations nouvelles (épidémies, ruptures de certains stocks).

Conclusions

Le discours sur les facteurs déterminants de la performance ou de la défaillance des systèmes locaux de santé dans les pays à faibles et moyens revenus demeure largement focalisé sur des considérations technocratiques et financières, ciblant les réformes institutionnelles, la disponibilité des ressources, ou l'accessibilité des services de santé. À l'opposé, le rôle du leadership des responsables de district et plus généralement, de ce qu'on appelle « le facteur humain », dans la performance des systèmes de santé locaux n'est évoqué que très marginalement. Cette étude montre qu'un leadership fort et engagé

favorise une mobilisation efficace des équipes et crée les conditions d'une bonne performance des districts, y compris lorsque ces derniers n'ont qu'un accès limité à des soutiens provenant de partenaires extérieurs.